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The Geographical Journal

Vol. LXV No. 6 June 1925

INNERMOST ASIA: ITS GEOGRAPHY AS A FACTOR IN HISTORY

Sir Aurel Stein, K.C.I.E., F.B.A.

The First "Asia Lecture."

Continued from page 403. *General Map following page* 556.

IT is necessary to keep well in view the exceptional importance and advantages which the Tarim basin possessed for the Chinese as a safe line of passage for trade intercourse and political expansion westwards, if we are to understand the reasons which induced them to face and overcome the forbidding natural difficulties besetting access to it. The explorations carried on during my winter campaigns of 1907 and 1914 enabled me to trace the route used for Wuti's enterprises over the formidable wastes of sand, bare gravel, and salt which it crossed. For all detailed evidence regarding its line and the physical conditions prevailing along it in ancient times I must refer to 'Serindia' and to the final report on my third Central-Asian expedition now ready for the press. But the observations made in the course of those explorations are of sufficient geographical interest to warrant our retracing the line, be it only in a rapid sketch.

Let us start from the side of China and its north-western marches in the great province of Kansu. We have already seen in our description of the drainageless basins of the Etsin Gol and Sulo Ho that the submontane belt on the northern slopes of the Nan Shan provided a great natural corridor westwards, easy both to follow and to protect. Abundantly watered from perpetual snow-beds of the Nan Shan, it could as far as Suchow furnish produce amply sufficient for the needs of any number of men and animals that trade or military movements might bring along it. From Suchow onwards the ancient route undoubtedly led, just like the present high-road into Chinese Turkistan, through the succession of small oases which extend along the left bank of the Sulo Ho as far as Tunhwang. To the north of the river there stretch the gravel and stone wastes of the Pei Shan Gobi right away to the foot of the easternmost Tien Shan (Pl. 25). In spite of their barrenness they were in ancient times as little as now impassable for small parties. Hence

there was need for the protection which the *Limes* line of the Emperor Wuti here provided against Hun raids. I could trace it first along the northern bank of the Sulo Ho to the river's last defile at the Wanshantze ridge and thence south of the river towards Tunhwang.

This oasis, in spite of many vicissitudes, including utter devastation during the last great Tungan rebellion, is still a place of some modest resources. It was destined by nature to serve as the base for the early Chinese advance into the Tarim basin. It was then, as now, the last locality capable of cultivation. Beyond it the route had to cross some 300 miles of true desert before striking the once habitable area in the now dried-up delta of the ancient Quruq Darya. West of Tunhwang down to the terminal marshes of the Sulo Ho there extends a bare gravel desert. Narrow strips of reed beds and other desert vegetation are found only along the deep-cut bed of the Sulo Ho and along the succession of small lakes which the dying river feeds at the time of its summer floods.

Desolate as this ground is, it is here that my explorations have revealed the most striking evidence of the thoroughness with which Chinese power of systematic organization had prepared for the safe use of the difficult route into the Tarim basin ever since it was first opened. We know from Chinese historical records, as already mentioned, that immediately after the success achieved by the second expedition against Ferghana (102–101 B.C.) the road from Tunhwang westwards to the "Salt Marsh" was protected by military posts. The westernmost extension of the Emperor Wuti's *Limes* is meant here, and of this my explorations have enabled me to recover the remains in an unbroken line and in a remarkable state of preservation.

The exceptional aridity of the climate prevailing here ever since the *Limes* was constructed made it possible to discover many very interesting relics of the life led during the first two centuries before and after Christ along this most desolate of borders. Among the hundreds of Chinese documents on wood excavated by me at the ruined watch-stations and deciphered by that lamented great scholar and incomparable collaborator M. Chavannes, there are a number of which the exact dates take us back to the very beginning of the first century B.C. The latest do not come down beyond the middle of the second century A.D., when altered political conditions caused the guarding of the *Limes* to be abandoned. Most of these records, written not only on wood but also on silk and in a few instances on the oldest known paper, were found in shallow refuse heaps on to which they had been thrown from time to time out of the military clerks' offices. Their survival here, protected often only by a few inches of gravel, bears conclusive testimony to the atmospheric conditions on this desert ground having been more than two thousand years ago quite as dry as they are now.

Equally interesting from the geographer's point of view is the evidence afforded by the wall or *agger* along which the ruined posts of the *Limes*

with their watch-towers were placed at distances varying from about one to two miles according to the character of the ground. It was throughout constructed of carefully secured layers of fascines alternating with layers of stamped clay or gravel. This method was specially suited to withstand the most destructive of nature's forces in this desert region, slow grinding but almost incessant wind-erosion. It was, besides, the only one practically adapted to rapid construction on ground bare of all resources and over great distances even devoid of water. Along those sections where the *Limes* line lay parallel to the prevailing direction of the winds, blowing mostly from the east and north-east and often with great violence and persistence, the wall still rises in remarkable preservation, in places to a height of 10 feet or more (Pl. 29). Its survival in spite of the apparently perishable nature of the materials used conclusively proves that the climate on this ground has been arid in the extreme ever since the wall was first constructed more than two thousand years ago.

Incidentally I may also mention here the curious collateral evidence furnished by the materials used for the fascines which served to assure cohesion of the wall. Generally these were made of reeds, the material readily obtainable from the reed beds still found in the riverine depressions along the Sulo Ho. But in certain sections of the wall the reed bundles are replaced by fascines made of tamarisk brushwood or branches of the wild poplar, and it is significant that this growth of desert vegetation is just the one now found on the ground through, or near, which those sections of the *Limes* pass. Economy of effort has at all times been a characteristic feature of Chinese methods of work, and here we have a proof of it in the intelligent adaptation to the local resources.

Nor should I here omit an observation which has a direct bearing on that much-discussed question of climatic change usually spoken of in connection with Central Asia as "desiccation." In keeping with its character as a portion of the "Great Wall," the *Limes* west of Tunhwang shows a continuous line of wall except in places where the general direction permitted its designers to substitute for it impassable marshes or lakes, and thus to economize in constructive effort. Exactly the same method is found in certain *Limes* lines of the Romans where a "wet border" had been inserted into a chain of frontier posts. Now where the line of the Tunhwang *Limes* thus abutted on small lakes or marshes, remains of the wall were ordinarily traceable to a level within a few feet of that still reached by the water. This suggests that the volume of water received by these depressions could not have greatly varied since Wuti's *Limes* was constructed.

This is not the place to indicate the many interesting glimpses which the mass of ancient record recovered gives us of the organization of the troops (largely recruited from convicts) guarding the *Limes* line; of

the elaborate system of supplies and transport provided for them; of the service of fire signals maintained along the line, etc. It must suffice to call attention to the evidence which the great size and solidity of the ruined magazine still rising close to the actual caravan route behind the *Limes* affords of the traffic once passing along it (Pl. 24). Throughout the disposition of the watch-posts, sectional headquarters, etc., bears testimony to that remarkable eye for topography which has always distinguished the Chinese. The use of this particular quality for strategic purposes is well illustrated by the way in which those old military engineers of the Emperor Wuti secured a natural flanking defence for their *Limes* line by letting it end close to the terminal marsh basin of the Sulo Ho (Pl. 30).

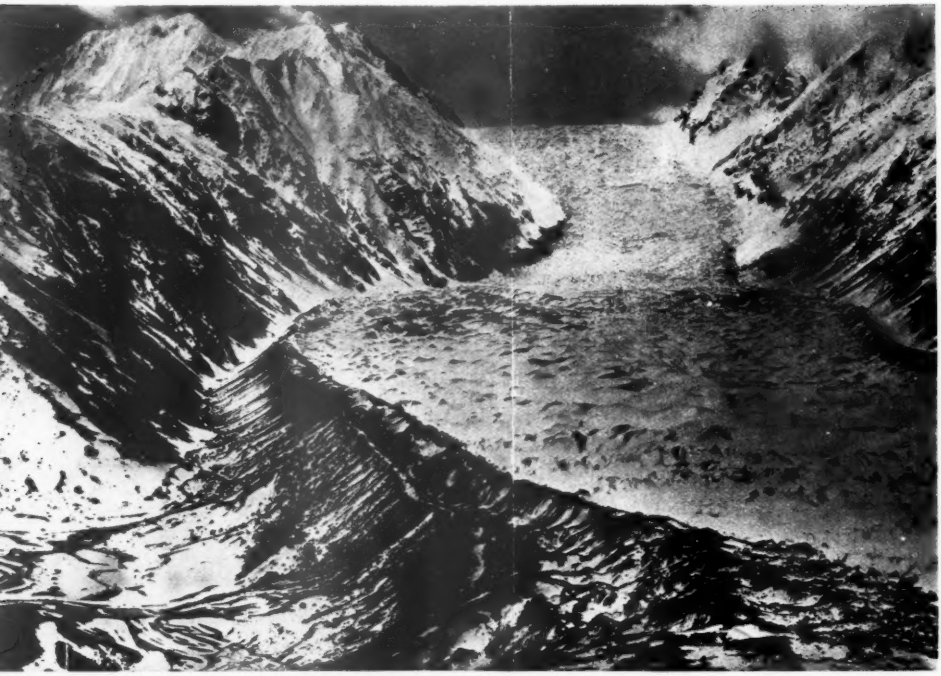
Beyond this the direction of the ancient route is indicated only by a couple of advanced signal towers along the present caravan track leading towards Lop and by the configuration of the ground. This marks out the desert valley of Besh Toghraq as the only practicable line for further progress between the utterly waterless wastes of the Quruq Tagh in the north and the high dunes of the Qum Tagh, or "Sand mountains," in the south. Here obviously there was no need for assuring safety by a *Limes;* for nature itself had provided for the defence of the route line against raids by impassable deserts on either side. And here the question obviously obtrudes itself as to why the Chinese, in spite of very serious difficulties and their traditional aim at economy of effort, had found it at all necessary to carry their protective line of wall and towers so far beyond the oasis of Tunhwang.

The answer to this question is, I think, clear, but obliges us for a moment to turn our attention away to the north. There at a distance of only some 200 miles in a straight line from Tunhwang lies the oasis of Hami at the foot of the Qarliq Tagh (Pl. 14), the easternmost snowy outlier of the Tien Shan. This important area of cultivation provides the natural bridge-head for the easiest route connecting Eastern Turkistan with the Kansu marches. Through it now passes practically the whole of the traffic between the two regions. But at the time of the first expansion of Chinese power into Central Asia and for fully two centuries later Hami was in the power of the Huns who in the great Barkul valley just across the Tien Shan and elsewhere on the northern slopes of the Qarliq Tagh held congenial grazing-grounds amply provided with water. As long as the Hun nation remained a formidable neighbour on the north-western borders no permanent advance to the Tien Shan across the "Gobi" of the Pei Shan could safely be undertaken by the Chinese. Yet without securing a hold upon Hami it was impossible for them to prevent Hun raiding parties crossing the Pei Shan towards Tunhwang and the terminal course of the Sulo Ho beyond it; for in this central portion of the Pei Shan well water for small parties of horsemen can even now be found at certain points, and along the marsh-lined bed of the Sulo Ho such bands could

20 DARKOT AND CHATIBOI GLACIERS, SEEN FROM T
On left the Darkot Glacier, over which the ascent to the Darkot Pass (15,600 feet)

21 ASCENT TO DARKOT PASS FROM NORTH, WITH

EN FROM THE FOOT OF THE RUKANG SPUR, MASTUJ
(15,600 feet) leads. On right the Chatiboi Glacier, below Koyozum Peak (22,603 feet)



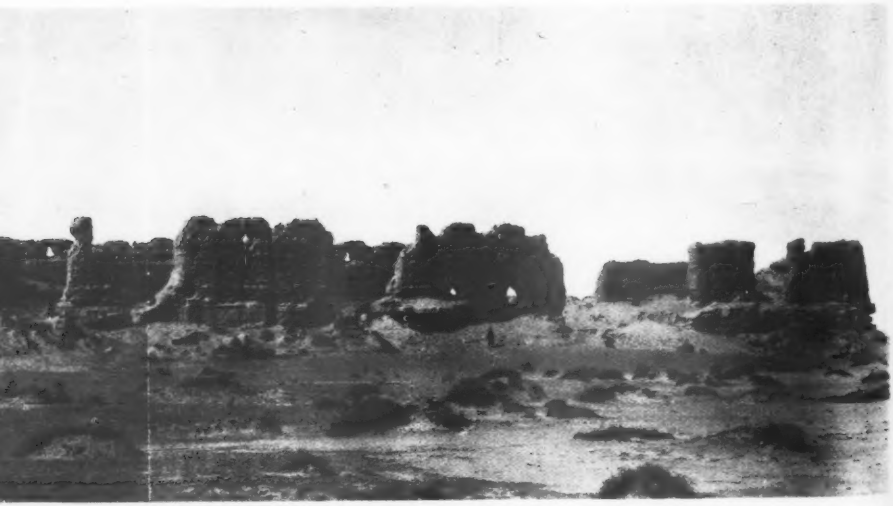
ORTH, WITH CREVASSED GLACIER IN FOREGROUND

22. VIEW TO SOUTH-EAST AND SOUTH, FROM RUINED STUPA OF
In foreground remains of ruined dwellings, showing original surface level. At *A* tra

23. BODY OF NATIVE OF ANCIENT LOULAN, IN GRAVE OF CEMETERY EXPLORED ON MESA L.F.

24. RI

STUPA OF LOULAN SITE, ACROSS WIND-ERODED GROUND
evel. At *A* traces of eastern face of ancient circumvallation carried off by wind



24. RUINS OF ANCIENT CHINESE MAGAZINE ON *LIMES* OF TUNHWANG

always collect with ease and prepare for attacks. Hence arose the need for the executors of Wuti's Central-Asian policy to extend their *Limes* right away to the river's termination.

The difficulties of nature which beyond this had to be faced by the Chinese on their earliest route into the Tarim basin were great indeed. They might well have appeared altogether prohibitive from the point where it reached the bed of the dried-up salt sea which had to be crossed to Loulan, in the ancient delta of the Quruq Darya. But the Chinese at all times have been far more willing to face and overcome the difficulties and dangers of nature, however formidable, than to struggle with barbarian foes—ready to expose their lives and to endanger those of others. Thus alone can we account for the line followed by that ancient highway, for the most part over truly forbidding ground.

In tracing its line we are aided to some extent by the data which brief references in the Han Annals and a couple of Chinese historical texts composed somewhat later furnish as to successive stages of the route. But it is only since the surveys and archæological discoveries made on my third expedition that we can arrive at definite conclusions regarding it. I have had occasion to indicate the main outlines of these conclusions in 'Serindia,' and to discuss the evidence for them fully in 'Innermost Asia,' my forthcoming detailed report. The topographical facts are recorded in the Lop desert sheets (Nos. 29, 30, 32, 35) of the recently published atlas, 1:500,000, of my Central-Asian surveys. To these publications I may refer for all details.

Over a distance of close on 140 miles the general direction of the ancient route is adequately determined by the configuration of the ground. Starting from the extreme western point of the *Limes* the route was bound to lie along the desert depression which separates the southernmost chain of the utterly barren Quruq Tagh from the high sand-ridges of the Qum Tagh. This depression, as already noted before, contains the easternmost bay-like extension of the dried-up Lop sea. It may be called the Besh Toghraq valley from the name of the halting-place at its head. Past this leads the caravan track which was once followed by Marco Polo and after the abandonment of centuries was brought into rare use again in recent years. Further on it skirts the southern shore of the great salt-encrusted sea-bed (Pl. 27).

In order to reach this point the route in ancient as in modern times had to cross an earlier terminal basin of the Sulo Ho filled with a maze of fantastically eroded clay terraces or *Mesas* (Pl. 28). A series of high ridges of drift sand projects into this basin and accounts for the name of *Sanlung-hsia*, the "Three Sand-ridges," which an early Chinese itinerary, in the *Wei lio*, mentions near the first stage on the route to Loulan. At Besh Toghraq, which boasts of two wells less brackish than the rest in this valley, the line of the ancient route separates from the track still followed by occasional caravans towards Lop and continues along the

northern edge of the gradually widening bay. Strips of ground covered with light drift-sand and scanty desert vegetation intervene here between the well-defined shore-line of the prehistoric sea and the dismal expanse of salt crust, mostly hard but in places still boggy, which marks its former extension into this bay. Thus for a distance of about 80 miles from Besh Toghraq we may suppose that those following the ancient Chinese "route of the centre," as the *Wei lio* calls it, could still count upon finding in places water, not altogether undrinkable, and a minimum of reeds and scrub for their animals.

The difficulties of moving large convoys and big bodies of troops over desert ground so far from the nearest supply base at Tunhwang must have been serious enough. But they were as nothing compared with the formidable obstacles to be faced on the onward journey to Loulan. About 16 miles beyond the point where nowadays the last trace of vegetation is found, though no drinkable water, a final offshoot of the hill chain so far followed juts out into a vast expanse of hard salt crust (Pl. 34). This stretches here away, absolutely level and unbroken like the open sea, over some 180° of the compass. Here the salt-encrusted great bay which the route has skirted merges in the eastern extremity of the dried-up Lop sea-bed. To trace from this point onwards the route by which those old Chinese wayfarers had made their way to Loulan, still close on 100 miles off to the west in a straight line, would have been an impossible problem if attempted from this side. The forbidding salt waste ahead would afford no landmark to the traveller, and similarly the old Chinese accounts fail us as regards direction, stages, or distances. But they show clearly enough the terror with which this portion of the journey was regarded.

It was only from the opposite side, that of Loulan, that any attempt could be made with any chance of success, and, let me add, with due regard for safety. In the preliminary account I gave before you when I returned from my third expedition,* I had already occasion to relate how in the winter of 1914, helped by archæological discoveries and some measure of luck, I succeeded in tracking the ancient route through this waterless wilderness. But the story bears, perhaps, repeating in brief outlines, be it only for the light which some of its incidents throw upon the physical conditions now prevailing on this ground and on the life long ago departed of which it was once the scene.

The explorations which I carried out in 1906 among ruins first discovered by Dr. Hedin in the dried-up delta of the Quruq Darya, had furnished full archæological proof that they marked the site of an ancient station occupied under Chinese control down to the third century A.D. The documents found there made it clear beyond all doubt that it had served as the western bridge-head, as it were, in Loulan territory for the route which crossed the Lop desert towards Tunhwang. Excava-

* See *Geographical Journal*, August–September, 1916.

tions and surveys resumed in February 1914 enabled me to make further interesting discoveries, *inter alia* to trace remains of the square circumvallation which once enclosed the main site (Pl. 22). Excessive wind erosion, proceeding since moisture and vegetation departed, has sculptured this ground into a maze of steep clay terraces and trenches (Pl. 31), and has almost completely carried off the once massive ramparts. But of particular importance for the main task which had drawn me back to this desolate ground, now close on 100 miles away from the nearest drinkable water, were the results of reconnaissances made into the desert north-eastwards. They revealed there a succession of remains which clearly indicated that the ancient route towards China had followed that direction, at least in its initial portion.

The nearest among these was a cemetery situated some 4 miles off on the top of an isolated clay terrace or *Mesa*. Rapid clearing revealed that it contained grave-pits into which miscellaneous relics of earlier burials had been collected by pious hands at some period before Loulan was finally abandoned. The mass of beautiful figured silks, both polychrome and damasks, here recovered have proved quite a revelation as regards the artistic style and technical perfection of those products of Chinese silk-weaving which travelled westwards through Loulan while trade still followed this route.* Collateral evidence proves that the original burials belonged to the early period of Chinese expansion into the Tarim basin, and that they had undergone already prolonged exposure to erosion before the danger of complete destruction caused them to be collected in these pits.

These relics of Chinese textile art from the time of Christ and before, claim special interest because they have been preserved for us on the very route of the earliest silk trade. But equally important is it for the student of those early relations between the Far East and the West to note that among the decorated fabrics there are found fragments of exquisitely worked tapestries in wool which display a style unmistakably Hellenistic. Whether they are of local make or imports from Central-Asian territories further west, we have in them striking illustration of a cultural influence which that ancient desert route also served for centuries, but in the reverse direction.

Continuing to the north-east for another 12 miles, we soon left behind the last dry river-bed once fed by the Quruq Darya (Pl. 26) and still marked by trunks of wild poplars and tamarisks dead for centuries. Then we came upon the ruins of a small walled *castrum*, undoubtedly once serving as an advanced *point d'appui* on the road from Tunhwang. Its walls, built with alternate layers of carefully secured reed fascines and stamped clay, showed such close agreement in all constructive details with

* For a preliminary account of these textile finds, see F. H. Andrews, "Ancient Chinese Figured Silks excavated by Sir Aurel Stein" (*The Burlington Magazine*, 1920).

the wall of the westernmost Chinese *Limes* that there could be no doubt about its dating, just as this does, from the first military advance of the Chinese into the Tarim basin. The destructive forces of two thousand years had not succeeded in seriously breaching these massive walls. Under their shelter dated Chinese records survived, belonging like most of those found at the Loulan station to the period preceding the final abandonment of the route, soon after the end of the third century A.D. But the interior of the fort had suffered terrible havoc through wind-erosion scooping out deep hollows.

All the more gratifying was the remarkable state of preservation which the elevated position on the top of a high *Mesa*, together with the exceptional aridity of the climate since ancient times, had assured to remains of an outlying look-out post traced some 3 miles further to the north-east. Here we found graves holding bodies of the indigenous Loulan people who once tenanted the small stronghold (Pl. 23). Several of the bodies were so wonderfully well conserved, together with their burial deposits, that I felt myself brought here face to face with the race of semi-nomadic herdsmen and hunters whom the Han Annals describe as the native population of Loulan. Their features showed close affinity to that *Homo alpinus* type which, as the anthropometrical materials collected by me have proved, still continues the chief element in the racial constitution of the present population of the Tarim basin. The distant view gained from this elevated point made it certain that we were here near the eastern extremity of the ground once reached by life-giving water from the river. Beyond to the east there lay the boundless expanse of shimmering salt, marking the dried-up sea-bed.

The topographical indications I deduced from the position of the remains successively discovered seemed to point to the ancient route having lain to the north-east. Yet this bearing would lead us at right angles away from the line on which, as our preceding mapping showed, we should have to look for the direct route to the debouchure of the Besh Toghraq valley. It was an observation distinctly discouraging with regard to the search we should have to make for the ancient route. The ground ahead was sure to prove devoid of all resources for human life, including water. Careful preparation was essential for ensuring safety on such a journey through an absolute wilderness. By its estimated length of at least ten days it was bound to put to a severe test the endurance of our brave camels, already hard tried by work of the preceding weeks. So it became necessary at this stage to gain first the distant salt springs of Altmish Bulaq at the foot of the Quruq Tagh to the north, in order that the camels might gather fresh strength by a few days' grazing at reed-beds as well as by the chance of a drink.

After two trying marches from Altmish Bulaq, across a perfect maze of steep clay terraces and hillocks encrusted with hard salt, we regained the vicinity of that outlying little fort. There I was fortunate enough to

discover more remains confirming my conjectural conclusion that the initial bearing of the route lay to the north-east. At the very edge of the area showing some dead vegetation I came upon the remains, almost completely eroded, of an ancient watch-tower of the type familiar from the *Limes*. Beyond this there were no ruins to guide us; for we were now passing into ground which all through historical times must have been as devoid of plant or animal life as it now is.

But as we steered north-eastwards by the compass across absolutely barren wastes of clayey detritus or salt crust, chance came again and again to our help by strange finds. They seemed as if meant to assure us that we were still near the ancient track by which Chinese missions, troops, and traders had toiled for four centuries through this lifeless wilderness; that I was right in my reliance on the Chinese with their topographical sense having for good reasons selected this bearing, puzzling as it seemed at the time.

It must suffice here to mention what perhaps was the most striking and welcome of these finds. The last traces of dead vegetation marking the termination of the ancient delta had long remained behind when we suddenly found the old route line plainly marked by some two hundred Chinese copper coins strewing the dismal ground of salt-encrusted clay for a distance of about 30 yards. They lay in a well-defined line running from north-east to south-west. The coins, square-holed, were all of the Han type and seemed as if fresh from some mint. Clearly they had got loose from the string which tied them, and gradually dropped out through an opening of the bag or case in which they were being carried by some convoy. Some 50 yards away in the same direction there were scattered bronze arrow-heads, all manifestly unused. Their shape and weight exactly agreed with the ammunition of Han times so familiar to me from finds along the *Limes* of Tunhwang. There could be little doubt that coins and arrow-heads had dropped from some convoy of stores proceeding to Loulan in Han times. Their having remained on the ground is easily accounted for if the convoy moved at night-time and a little off the main track but still in the right direction.

That day's long march was taking us past a far-stretching array of big *Mesas* which with their fantastically eroded shapes curiously suggested ruined towers, mansions, or temples. It was easy to recognize in them those wind-eroded mounds which an early Chinese text mentions near the north-western edge of *P'u-ch'ang*, or the ancient Lop sea-bed, and in which Chinese eyes saw the ruins of a mythical "town of the dragon." Finally, after continuing our north-easterly course for another day across bare clay and mica detritus, we arrived at a forbidding belt of salt-coated erosion terraces (Pl. 35). They clearly corresponded to those which Chinese notices of the ancient route to Loulan repeatedly mention as the dreaded "White Dragon Mounds," and graphically describe. Progress between them was very trying for our poor camels' feet, and also for us

men. But still worse it was to face the crossing of the bed of the dead Lop sea with its terrible salt surface which I knew to lie beyond.

A fortunate find of Chinese coins and metal objects marking a halting-place on the ancient route induced me now to head straight eastwards for that bed, and the crossing effected next day proved that I had been rightly guided. The march of 20 miles across this petrified sea-bed, with its hard salt crust crumpled up into big cakes aslant and small pressure ridges between them (Pl. 36), was most fatiguing for men and beasts alike. But subsequent surveys showed that without several days' détour northward the crossing of this forbidding salt surface could not have been shortened, but on the contrary only lengthened.

It was, no doubt, this consideration which had determined the early Chinese pioneers in the choice of this line for their route. Archæological evidence of ancient traffic on it cropped up again soon in the shape of coins and beads, when through the opposite belt of "White Dragon Mounds" we had gained the eastern shores of the ancient salt marsh. Three marches along these over ground easy but still devoid of any trace of vegetation, dead or living, finally brought us to the debouchure of the Besh Toghraq valley. There I found the ancient Chinese road still plainly marked in one place by the straight wide track which the passage for centuries of transport animals, and probably also carts, had worn into the salt-encrusted ground.

How traffic of such magnitude as the Chinese Annals indicate was organized and maintained on a route passing across some 120 miles of utterly barren ground, already in ancient times without water, fuel, or grazing, is a problem we need not discuss here. But it is well to keep in view that great power of organization which was needed to solve it in practice, if we are adequately to realize the remarkable qualities which enabled the Chinese for centuries to control and keep open that far-stretched corridor of the Tarim basin. It was an achievement fraught with momentous results for the interchange of civilizations, and there is deep significance in the fact that it was due far more to prestige, economic resources, and political ability on the side of China than to any military prowess among its people or its rulers. It may well, in fact, be looked upon as a triumph of the mind over matter, whether manifested in space or in brute force.

The intercourse thus established through Central Asia suffered its first interruption about the beginning of our era through the rapid decay of internal order which took place in China during the short-lived reigns of the last two emperors of the Former Han dynasty (6 B.C.–A.D. 5). With the consequent weakening of Chinese control in the Tarim basin "the principalities of the Western countries," we are told in Later Han Annals, "broke up and formed fifty-five territories." When, on the accession of the usurper Wang Mang (A.D. 9), trouble arose with the Shanyü or supreme chief of the Huns, the territories before controlled

by the Protector-General in the Tarim basin and near it " broke off all relations with the Middle Kingdom and all again submitted to the Huns." The exactions of the Huns made those petty chiefships turn, indeed, again to China for protection towards the middle of the first century. But the empire reconstituted under the founder of the Later Han dynasty was not as yet sufficiently consolidated to resume a policy of Central-Asian expansion. The north-western marches of Kansu subsequently became exposed to prolonged raids from the Huns, until at last the need of effective protection for its borders forced the Chinese empire again to start upon a " forward policy " in Central Asia.

It is interesting to note that the first move made in A.D. 73 under the Emperor Ming was aimed directly at the Huns by the taking of Hami. This strategically very important oasis was the key to that " route of the north " which passed along the foot of the eastern Tien Shan and through the Turfan depression. It was destined by nature to serve as the easiest road into the Tarim basin—provided it could be protected against nomadic attacks from across the Tien Shan. Some temporary weakening in the power of the Huns still holding the grazing-grounds to the north appears to have influenced this diversion of the Chinese effort to a new line. But its success was short-lived ; for though the chiefs of the small territories in the Tarim basin had promptly offered allegiance after that first forward move, and again invited a Chinese " Protector-General," the difficulty of maintaining a hold on that exposed northern line forced the Emperor Chang, Ming's successor, by A.D. 77 to evacuate both Hami and Turfan.

It was not until thirteen years later that Hami was re-occupied by the Chinese. But meanwhile the Tarim basin had become the scene of events which in the end placed the empire once again in undisputed possession of that great passage land. Incidentally they also proved the value of the desert route first opened from the side of Tunhwang nearly two centuries earlier. This is not the place to relate the story of the remarkable exploits by which the famous Pan Ch'ao, the greatest of the soldier statesmen who ever served China's Central-Asian policy, re-established effective imperial authority throughout the Tarim basin. It must suffice for us to note that Pan Ch'ao started his series of brilliant successes when deputed in a subordinate capacity to the chief of Shan-shan, as the Lop territory, the ancient Loulan, had been renamed in the first century B.C. By a bold night attack made with a handful of men, he surprised and exterminated a mission sent there by the Huns. Then, having thus safeguarded the line of communication with China, he proceeded to win his way by the " southern route " all along the foot of the Kunlun. Gradually he gained mastery over the chiefs of Khotan, Yarkand, and Kashgar, not by the force of arms but by bold bluff and skilful diplomacy. Pan Ch'ao's maxim, as stated by him in a very interesting memorial to the Emperor which the Annals have preserved, " was to use the barbarians for attacking the barbarians." Thus securing

needful support in the country itself, he succeeded after many set-backs and hard struggles in steadily extending Chinese supremacy over the "Western Countries," until by A.D. 94 the last of the powerful kingdoms along the Tien Shan had been forced into submission.

Chinese political influence had, in consequence of Pan Ch'ao's triumphs, been extended westwards even beyond the Tsungling or the Pamirs. Diplomatic relations were established with the Parthians and direct contact sought with distant Ta Ts'in or Syria by means of a mission which A.D. 97 appears to have reached the sea in the Persian Gulf. By A.D. 102, when Pan Ch'ao, grown old and laden with imperial honours, returned to the distant capital soon to end his days there, Chinese prestige and power in Central Asia may be said to have reached its apogee.

It is just about this time that we may assume *Scythia extra Imaon*, or the Tarim basin, to have been traversed by the trade agents of that Macedonian merchant, Maës Titianus, whose reports enabled Marinus of Tyre and through him Ptolemy, the Alexandrian geographer, to furnish us with information on the route followed by the caravans bringing to the West the silk of far-off Serike, the land of the Seres, *i.e.* China. But the same period probably witnessed also the first important developments in the use of that maritime route through the Red Sea and the Indian Ocean which made exchange of merchandise, whether direct or through Indian channels, possible between China and the trade centres of Egypt and Syria.

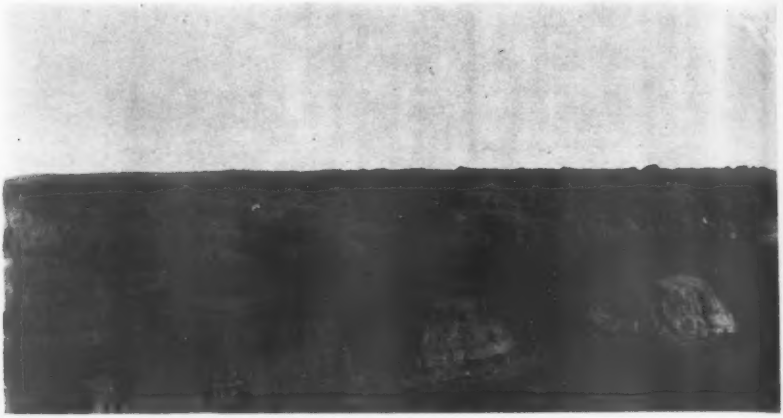
The opening of this new channel of commercial intercourse between China and the West may not have immediately affected the importance of the Central-Asian trade route. But changes more local took place likely to hamper its use. By A.D. 107 revolts among the "Western Countries" and subsequent inroads of the Huns led to the complete withdrawal of Chinese control from the Tarim basin. From A.D. 123 onwards endeavours were made to recover the ground lost. It is of interest to note that the first efforts, carried out under the leadership of Pan Yung, Pan Ch'ao's son, were based upon the ancient route *viâ* Loulan and first directed towards Turfan. Hami was not re-occupied until A.D. 131, when the Huns had been defeated north of the Tien Shan. But in spite of the partial successes recorded, the Later Han Annals clearly tell us that imperial prestige gradually decayed in the Western Regions during the century of increasing internal weakness which preceded the final downfall of the dynasty, A.D. 220.

The epoch of the "Three Kingdoms" which followed this event saw China divided between rival dynasties. Effective Chinese control over the whole of the Tarim basin was not likely to be maintained in these troubled times. Hence references to the Western Regions are scanty enough in the historical texts dealing with this period (A.D. 220–265) and that of the Chin dynasty (A.D. 265–419) which succeeded. Yet there is evidence that those territories still continued to be open to trade

25. CAMP TO N.W. OF MINGSHUI WELLS, PEI SHAN

26. DRY BED IN DEAD DELTA OF QURUQ DARYA, N.E. OF LOULAN SITE

27. SALT SPRING OF LOVAZA, WITH ICE SHEET BELOW OLD SHORE-LINE, AND VIEW ACROSS SALT-ENCRUSTED LOP SEA BED



28. WIND-ERODED TERRACES (MESAS), 100-120 FEET HIGH, IN ANCIENT TERMINAL BASIN SULO HO

29. ANCIENT CHINESE BORDER WALL BUILT WITH LAYERS OF REED FASCINES. EAST OF WATCH-STATION T.XIII., ON *LIMES* OF TUNHWANG

30. RUIN OF ANCIENT WATCH-TOWER, T.IV.C. ON WESTERN FLANK OF TUNHWANG *LIMES*, WITH VIEW ACROSS ERODED BASIN TO NORTH

and cultural influences both from the East and the West, even though political power from the side of China could assert itself only intermittently and in the parts nearest to the Kansu marches.

The evidence I allude to is fortunately supplied not merely by such brief notices as M. Chavannes' learning has rendered accessible from the *Wei lio* and the Chin Annals, but by the abundant remains of two very interesting ruined sites I have been able to explore. I mean the ancient settlement brought to light in the desert sands beyond the termination of the Niya river, and the ruins at and around the ancient Chinese station of Loulan, which I have already had occasion to mention as the western bridge-head of the earliest Chinese route into the Tarim basin.

In ' Desert Cathay ' and ' Serindia,' as well as in the publications on my first expedition which led to the discovery of the Niya site, I have found occasion to deal at length with the manifold interesting aspects of the conditions of life and administration revealed by the remains both there and in the Lop area. Here only the most characteristic among them may be noted before we turn to those questions of direct geographical import which are raised by the abandonment of both sites to the desert and the state of utter desolation now prevailing there. Both at the Niya site and in Loulan we have the evidence of dated documents proving that occupation had continued until about the close of the third century of our era.

This approximately contemporary occupation accounts for the close similarity observed in most features of the ruins and of the finds their exploration has yielded, though the two sites are separated by a direct distance of close on 500 miles. At the Niya Site, the *Chingchüeh* of the Han itineraries, it is easier for us to reconstruct the conditions of life once led there; for its ruined dwellings, scattered along the ancient termination of the Niya river over an area measuring about 15 miles from north to south, with a maximum width of about 4, are far more numerous. They have also suffered less by destructive wind-erosion, while abundant drift-sand has helped to protect whatever the last occupants had left behind.

The careful construction of the houses once tenanted by local officials or landlords (Pl. 33); remains of well-made household furniture and implements; objects of decorative art in the shape of fine wood-carvings, etc., all attest a highly developed state of civilization. The products of local industrial arts and crafts clearly show the prevalence of a strong Hellenistic influence as transmitted from Eastern Iran and the north-western borders of India. Yet the use of articles of Chinese workmanship, such as silk fabrics and fine lacquered ware, is also well attested. Finds of objects of Buddhist worship in the shape of shrines and relic towers or Stupas make it quite certain that Buddhism, India's greatest contribution to the spiritual development of civilized mankind, had by

that time already acquired that predominant position in the religious and intellectual life of the indigenous population of the Tarim basin which it was destined to preserve for nearly a thousand years.

This strong influence of Indian culture is very strikingly reflected also in the mass of written records recovered in the ruined dwellings and the refuse heaps adjoining. At the Niya site I found by the hundred wooden documents comprising correspondence, mainly official, contracts, accounts, miscellaneous memoranda, and the like, all written in that Sanskritic language and Kharoshthi script which during the first centuries before and after Christ were used on the Indian north-west frontier and in the adjacent portions of Afghanistan. But the ingenious methods of wooden stationery used for all these writings is undoubtedly of Chinese origin. Chinese records, also on wood, found at the Niya Site prove that some measure of Chinese control still extended so far west. But the local administration was carried on under the authority of native chiefs whom the Kharoshthi documents name under the title of "Maharaja." At the Loulan station the vast majority of the written remains found are in Chinese, and comparatively few in Kharoshthi and Early Sogdian, the language of the Oxus region; for there, so much further to the east, on the ancient main line of communication between China and the Tarim basin, Chinese authority, while it lasted, was bound to assert itself far more directly.

We are able with almost as much clearness to reconstruct the physical aspects of the life once witnessed by these sites. At the ancient settlement beyond the present end of the Niya river I could clearly make out the position and arrangement of the orchards and arbours, as marked by the trunks of their fruit trees and poplars, dead for over sixteen hundred years, but often still upright. Fences and hedges could be traced marking the enclosures of residences or fields (Pl. 32), and in places also the lines of the canals which had once carried life-giving water to the cultivated area. The terminal course of the Niya river, as it then ran, was definitely indicated by the footbridge at one place lying across a dry bed which elsewhere is completely overrun by tamarisk-cones or smothered under sand-dunes.

At the Loulan site the surface of the ground had been abraded far more through wind-erosion (Pl. 22), and hence could not retain the traces of ancient cultivation so clearly. But there, too, everything in the way of dead vegetation, materials used in buildings, etc., distinctly point to conditions of cultivation and climate having been essentially the same as those now observed in oases of the Tarim basin similarly situated and still occupied. For detailed observations supporting this conclusion I must refer to my previously mentioned publications.

Just as in the present terminal oases of the Tarim basin, so cultivation at those sites must have been entirely dependent on irrigation, moisture in the local atmosphere being a factor wholly negligible for agriculture.

Had not such conditions of extreme aridity already prevailed in ancient times, it would be impossible to account for the survival in almost perfect preservation of a multitude of objects, very perishable by nature, in places so exposed as refuse heaps outside houses. Yet there is abundant antiquarian evidence to prove that the accumulation of such refuse, including the " waste papers " of more than one local reign, must have proceeded over a considerable number of years.

Exactly corresponding observations are furnished by what archæological explorations at other ancient sites of the Tarim basin have taught us. Whether their remains are found in the desert sands beyond the present limits of Khotan and other southern oases, as *e.g.* at the sites of Dandan Öilik, Khadaliq, and Endere, or in now deserted localities of Kucha territory to the south of the Tien Shan, or eastwards in the depression of Turfan, the archæological evidence uniformly points to the same conclusion. The climatic conditions of the periods immediately preceding abandonment—periods varying here at different sites from about the fifth to the thirteenth or fourteenth centuries—must have been practically as arid as they were since and are now.

This uniform and important fact invests the question as to the cause or causes which led to the abandonment of all these old sites, with special interest both for the geographer and historical student. That question has received much attention in recent years owing to its connection with much-discussed theories of " desiccation " within historical times. If I were to attempt to examine all the facts bearing on this question which archæological and geographical exploration of ancient sites in Chinese Turkestan has yielded, a separate paper would be needed. Instead of this I shall content myself here with emphasizing two observations which ought to be kept prominently in view by those generally interested in the problem.

One concerns the necessity of realizing how varied the initial causes of abandonment may be in the case of individual sites before assuming *à priori*, be it only as a " working theory," that the cause must in each case be connected with some phase of general or regional " desiccation." Where settled occupation on any scale is possible only with the help of so elaborate an organization as artificial irrigation presupposes, its chances of development or shrinkage are affected by the uncertainties of human activity vastly more than on ground where nature itself provides for the fields that indispensable element of agricultural production, adequate moisture. The factors influencing human activity may be manifold and are often very complex, and cultivation wholly dependent on irrigation is particularly liable either to benefit or to suffer by them. To ascertain the factors which had a determining influence upon such cultivation at a given period must be very difficult, where no definite record is preserved ; for human factors quite different in character may produce results which may appear indistinguishable to those who after the lapse of

centuries attempt to trace their causes in the light of purely archæological evidence.

Thus in the Tarim basin quite a variety of causes entirely, or at least partly, of human origin might lead to reduction in the size of oases or even to the complete abandonment of outlying ones. Prolonged periods of war or internal disorder; devastating epidemics; changes in the beds of rivers rendering existing canal heads useless and producing results with which the local population is unable to cope owing to deficient resources of labour; diversion of traffic and trade causing labour to recede from certain oases which are separated from others by long distances of desert and hence difficult to protect or to render profitable:—all these causes and their effect upon the oases of this region can actually be illustrated from experience gained in recent periods. Other causes, too, of a similar character might be suggested on ground where the conditions of cultivation are so complicated and the technical means available for the maintenance of canals comparatively so primitive.

The results of such diverse causes as I have indicated, must in each case be the same, viz., abandonment of once cultivated ground. The same result would obviously be produced if the supply of water needed for irrigation were from some purely natural cause to undergo serious diminution or altogether to fail. On ground thus abandoned to the desert and subsequently left unreclaimed the ancient remains preserved through the aridity of the climate will enable us to fix the time of abandonment with more or less accuracy. But it is clear that the critical student will not be prepared to assign this abandonment to a particular cause, whether originating from nature or some human factor, unless definite evidence in the shape of reliable records or unmistakable archæological indications are forthcoming.

Unfortunately, at none of the old sites explored in this region do we as yet possess such evidence as methods of sound historical research would allow us to accept as conclusive. To make up for the regrettable want of such evidence by means of a "working theory" would be of no real help; for where matters of a historical past, more or less distant, are under consideration it is impossible to apply those experimental tests without which a "working theory," however tempting, must remain intrinsically useless.

There is, however, a second observation to be borne in mind in connection with the question of "desiccation" so far as it concerns innermost Asia, and for this can be claimed a more positive character, in view of what the ancient settlements discovered at the Niya Site and in the Lop desert teach us. The former at its northern end is separated by fully 70 miles from the nearest point in the present oasis of Niya where cultivation is now possible. Yet its irrigation comes from the same river which about seventeen hundred years ago still carried its water to the fields of ancient Chingchüeh, the now sand-buried Niya Site. In the case of

the remains of Loulan the change in this respect is even more striking; for the small oasis of Tikenlik, the nearest cultivated area on the Tarim which now receives the water once flowing in the Quruq Darya to Loulan, lies over 120 miles to the west of the extreme point once irrigated from the "Dry River."

The circumstances connected with this wide separation of the two ruined sites from the present end of the rivers to which they once owed their irrigation, are not exactly parallel. At the Niya Site we have a striking and perfectly clear instance of shrinkage in the volume and length of course of the river which until the third century A.D. rendered the existence of a terminal oasis possible so much further away than it does at present. There has been no change in the direction of the river course. This, as our mapping shows, still runs straight towards the site, though what little water it carries below the present Niya oasis dies away in the sand before reaching the ruined area. We observe conditions closely corresponding also at other ancient sites abandoned to the desert at the southern edge of the Taklamakan from Dandan Öilik to Endere.

In the Loulan tract the situation may at first sight seem somewhat different. Here we find that the Konche Darya which carries the drainage of the big Qara Shahr valley and once had its continuation in the Quruq Darya, instead of flowing eastwards to the Loulan sites, now turns to the south-east and joins the network of beds representing the lower course of the Tarim. Yet whatever the relation may have been between this diversion of the Konche Darya and the abandonment of ancient Loulan, there is every reason to believe that here, too, a very great shrinkage has taken place in the available volume of water since the times when the Quruq Darya fed the extensive delta traced to the east and south of the Loulan ruins. There are indications pointing to similar shrinkage also in the case of other rivers which descend from the Tien Shan into the Tarim basin.

If we review the observations just summarized in brief outlines, we are forced to two conclusions by definite archæological evidence. One is that climatic conditions quite as arid as the present ones prevailed within the big trough of the Tarim basin as far back as ancient remains and available records can take us. The other conclusion is that the amount of water carried by its rivers has greatly diminished during the same historical period. It is possible that geological and meteorological research may have more than one conjectural explanation to offer which would account for the apparent contrast between these two conclusions. But the explanation which at present appeals to me most is the one which Colonel Sir Sidney Burrard, late Surveyor-General of India, first verbally suggested to me in 1908 on my return from my second journey; and the same has been recently proposed by a competent observer, Dr. Ficker, with regard to similar conditions in the Oxus basin.

This theory seeks the reason for the diminished volume of the rivers in the shrinkage of the glaciers on the high ranges which are their main feeders. It accounts for the shrinkage itself by assuming that those glaciers comprise great reserves of ice which have been left behind by the last glacial period and have since been undergoing slow but continuous reduction through milder climatic conditions. This continued process would suffice to explain shrinkage in the irrigation resources during historical times without the climate of the basin as a whole having in the course of this period, very short in a geological sense as it seems, undergone any appreciable change.

Two facts might, as Sir Sidney Burrard thought, be adduced in support of this view: in the first place, the large size of the glaciers still in being on the northernmost Kunlun which seems to be disproportionate in comparison with the annual snowfall actually received by that range; and next the enormous masses of detritus which overlie all these Kunlun glaciers. The thickness of this detritus cover was very striking indeed, wherever I had occasion to survey the glaciers of the Khotan river's headwaters. It is bound to offer very effective protection for "dead" or "fossil" ice derived from a preceding glacial period. It finds its own explanation in the rapid decomposition which the rocks all over the Kunlun undergo through the great variation of extremes in diurnal temperatures.

But by whatever explanation we may endeavour to reconcile these two apparently discordant observations on the physical side, we cannot expect it, in the present state of our knowledge, to furnish a safe answer to the question as to the direct cause of their abandonment. The critical student has to keep well in mind the great complexity of the human factor and of all its actions. He cannot accept the cogency of the argument that because both ancient settlements were apparently abandoned to the desert approximately about the same period, therefore the cause of this change must necessarily have been identical. Certainly both these once cultivable areas have since the beginning of the fourth century A.D. become incapable of settled occupation owing to the impossibility of securing water for irrigation there. But it would obviously be a mistake to assume the *post hoc* as implying a *propter hoc* and then on the basis of such an assumption to try and interpret developments in the history of the Tarim basin or of Central Asia in general, mainly by conjecturally determined changes of climate.

Instead of such speculations it will be better to resume, however rapidly, our survey of the part which the Tarim basin by its geographical function as a great corridor played in later phases of Central-Asian history. For more than three centuries our knowledge of this history is very meagre indeed; for with the disappearance of Chinese political control our chief sources of trustworthy historical information about the "Western Regions," as furnished by the imperial Annals, dry up for

the most part. While China itself was divided between rival dynasties, several of them of foreign origin, the Huns in the course of the fourth century had started westwards on the great move which ultimately led them to water their horses on the Danube, Rhine, and Po. After an interval during which the rulers of different great oases appear to have disputed supremacy of the Tarim basin, the whole of this, together with vast territories to the north and west, passed for about a century under the domination of a branch of the Huns, known to the Chinese by the name of Juan-juan and in Western Asia as the Hephthalites, or White Huns.

Neither this domination from outside nor the period of contested sovereignty within, which preceded it, appears to have seriously affected the firm footing which Chinese civilization had acquired in the oases or to have interfered with the steady flow in the opposite direction of Buddhist doctrine and literary as well as art influence from easternmost Iran and India. The growing closeness of religious and intellectual relations thus established is reflected by the journeys of Chinese Buddhist pilgrims, who at this period made their way through the Tarim basin to the sacred places of Buddhism in distant India. Of their narratives those of Fa-hsien (A.D. 400) and Sung Yun (A.D. 519) are the only ones of any length preserved to us. They clearly show how cultural influences from both sides mingled in the territories which the pilgrims visited before descending across the Pamirs and Hindukush to the north-western borders of India.

Sung Yun had found the "Western Regions" he visited, together with the states of the Oxus basin, still subject to the Hephthalites or White Huns and one of their rulers holding sway on the Indus. But some thirty years later a fresh wave in the stream of nomadic migration which was moving westwards along the Tien Shan, slowly at one time, more rapidly at another, had put the great confederation of Turkish tribes, known to the Chinese as the Western T'ouchüeh, *i.e.* Turks, in ascendency over the vast Central-Asian region, previously dominated by the Hephthalites. Like their predecessors they were content to levy tribute from the settled territories to the south of their grazing-grounds. Hence trade and other intercourse between the Tarim basin and the rich territories to the west could continue unbroken. But the Western Turks and their allies, the Northern Turks, were in the east troublesome neighbours to the Chinese empire, which by A.D. 589 had after nearly three centuries of division become once more united.

Hence the gradual consolidation of Chinese power which continued after the accession of the great T'ang dynasty by A.D. 618, was at first accompanied by a policy of rigid seclusion on the north-western marches. We receive very interesting glimpses of the jealous care with which the routes leading towards the Tarim basin were then guarded, in the story of the greatest of Chinese Buddhist pilgrims, Hsüantsang, my Chinese

patron saint, as I used to call him. In a paper contributed some years ago to the *Geographical Journal* * I have traced the details of the adventurous desert crossing on which the young traveller, anxious in spite of imperial prohibition to set out for the holy places of Buddhism, escaped A.D. 630 the vigilance of the posts watching the frontier in the Tun-hwang region. The account of the extreme hardships and risks he encountered on his way across the Pei Shan to Hami, strikingly illustrates the "Chinese wall" policy which at that time tried to strangle China's intercourse with the West.

It was soon to give way to a "forward policy" on a grand scale which for over a century made Chinese imperial power under the T'ang dynasty expand over wider regions of Central Asia than it had ever before. When Hsüantsang after seventeen years' wandering returned to China *viâ* Khotan, A.D. 645, the northern line of access to the Tarim basin had already passed into Chinese hands. The ancient route through Loulan had by then been completely abandoned for centuries. The route along the easternmost Tien Shan was the only one practicable for serious military operations. The T'ang Annals fully acquaint us with the movements, significantly enough first directed towards the grazing-grounds on the northern slopes of the range, by which Hami and subsequently Turfan were wrested from Turkish supremacy. The power of the Western Turks was already weakened by tribal dissensions which Chinese diplomacy skilfully fostered. By A.D. 660 it was finally shattered by the Emperor Kaotsung's forces. China thus succeeded to their claim over a vast dominion extending from the Altai Mountains to beyond the Hindu Kush.

For a time the prestige of the imperial power and the diplomatic activity of its representatives sufficed to assert political control not only in the Tarim basin but also, in a more limited sense, over the territories now comprised in Russian Turkistan to the north of the Oxus. The routes of the Tarim basin must have seen then as much trade and traffic of all kinds as in the spacious times of the Han. The interchange of the influences, artistic and other, exercised at this period both from China on the one side and Persia, India, and the Near East on the other, are strikingly illustrated by the many finds which excavations at ruins of Turfan have yielded. Thus in the case of those conducted by myself at the seventh-century cemetery of Astana they included fine figured silks both of Chinese and pure Sassanian style, the latter undoubtedly manufatured in Eastern Iran or even nearer to the Mediterranean.

But this period of renewed Chinese expansion into Central Asia was not destined to be one of continued peaceful intercourse. The fact of China now claiming succession to the wide dominions once held by the Western Turks was bound to prove in time a source of trouble and weakness. The Chinese forces stationed in what were called "the

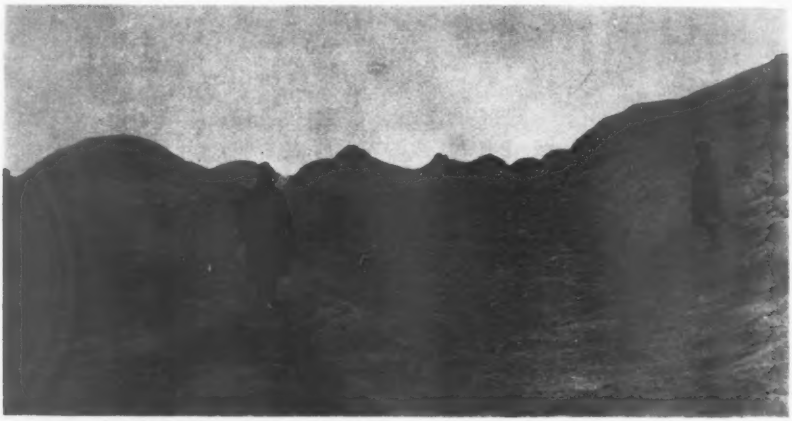
* See "The Desert Crossing of Hsüan-tsang," *Geo. Journ.*, November 1919.

31. WIND-ERODED GROUND OUTSIDE WESTERN FACE OF RUINED CIRCUMVALLATION, L.K., LOP DESERT

32. TAMARISK-CONES ABOVE WIND-ERODED GROUND AT SOUTHERN END OF ANCIENT SITE BEYOND NIYA RIVER END

33. CENTRAL HALL AND OFFICE ROOM IN RUINED RESIDENCE, N.XXIV., ANCIENT SITE BEYOND NIYA RIVER END, AFTER EXCAVATION

34. CARAVAN CROSSING SALT-ENCRUSTED BED OF ANCIENT LOP SEA



35. SALT-ENCRUSTED HILLOCKS OF "WHITE DRAGON MOUNDS" NEAR WESTERN SHORE OF DRIED-UP LOP SEA BED

36. CAMELS AMONGST BLOCKS OF HARD SALT, COVERING DRIED-UP BOTTOM OF ANCIENT LOP SEA

Four Garrisons" had to guard not merely the oases of the Tarim basin but also territories to the north of the Tien Shan. These offered attractive grazing-grounds to nomads, and were hence constantly subject to being disturbed by restless Turkish tribes. More serious still was the danger presented by aggression on the part of the Tibetans, who were then rapidly growing into a new military power. After the close of the seventh century they invaded the Tarim basin and were ever threatening the corridor between Tunhwang and Suchow.

Towards the middle of the eighth century there was added to the pressure from the Tibetans in the south fresh danger in the west from the steady advance of Arab conquest in the Oxus basin. The Tibetans were endeavouring to join hands with the Arabs as common foes of China's Central-Asian supremacy. By pushing down the Indus valley and thence across the Hindu Kush territories corresponding to the present Gilgit and Yasin they actually reached the uppermost Oxus valley. This junction threatened the Chinese position in the Tarim basin with being outflanked simultaneously both in the east and west. An effort had to be made to ward off this serious strategic risk. It led to an enterprise which stands out as perhaps the most memorable among the many proofs of Chinese capacity for overcoming by organization formidable geographical obstacles.*

In A.D. 747 the Deputy Protector-General of the "Four Garrisons," Kao Hsienchih, a general of Korean origin, collected a Chinese force of ten thousand men at Kashgar and led it through the gorges and passes of the Muz Tagh Ata range and across the inhospitable high valleys of the Pamirs to the uppermost Oxus. How such a force could be maintained in that elevated mountain region of the "Roof of the World" devoid of all resources, is a problem which might baffle any modern General Staff. But the detailed account preserved in the T'ang Annals which M. Chavannes' research has made accessible, proves that this most difficult task was faced and successfully overcome. After effecting a successful concentration at Sarhad, the highest habitable point in Wakhan, Kao Hsienchih completely defeated the Tibetan force which was guarding the Baroghil, the only pass across the Hindu Kush practicable for military purposes in this region.

But an achievement still more remarkable was his subsequent crossing of the very difficult glacier pass of the Darkot (Pls. 20, 21), at an elevation of 15,600 feet, with a Chinese force of three thousand men. I had twice occasion to cross the Darkot, and feel sure that those few British officers, first among them General Sir Edmund Barrow and the late General Lockhart, whom the duty of looking after the Hindu Kush defences of India has brought to this scene of Kao Hsienchih's exploit, would have thoroughly appreciated its greatness. If judged by the

* Cf. Stein, "A Chinese Expedition across the Pamirs and Hindukush," *Geo. Journ.*, February 1922.

physical difficulties encountered and vanquished, this crossing of the Darkot and the Pamirs may well be held to surpass the great Alpine feats of commanders famous in European history, from Hannibal to Napoleon and Suvorov.

The prestige accruing to the Chinese arms from Kao Hsienchih's expedition was deservedly great. But it did not save them from being signally worsted two years later. In a battle near Tashkent Kao Hsienchih was completely defeated by the Arabs and the revolted Turkish tribes, their allies. About A.D. 750 the Tibetans from the south secured mastery over Tunhwang and the adjoining tracts at the foot of the Nan Shan, and thus cut off the Tarim basin from all direct communication with the Chinese empire. Yet the Chinese administrators and garrisons within the former, notwithstanding their isolation, succeeded in holding out for another forty years—a heroic but obscure chapter in history.

In this long postponement of the final downfall we may well recognize direct proof, not only of the tenacious strength of Chinese organization, but also of the natural protection provided for the Tarim basin by the great mountain barriers in the north, west, and south and by the desert in the east. It is an interesting and, in more than one way, significant observation that the abandonment of a series of ancient sites in the Khotan region, such as Dandan Öilik, Khadaliq, Mazar Tagh, can be proved to synchronize with the end of Chinese control in T'ang times. It may well illustrate that dependence on ordered and fairly efficient administration which is so important a human factor wherever cultivation is wholly contingent on irrigation.

The period of about four hundred years following the disappearance of T'ang rule is a dark one in the history of the Tarim basin. We know that Tibetan domination in that region did not outlast a century, and also that Islam spread among the Turkish chiefs who acquired control over Kashgar and other oases in the western portion of the Tarim basin. From about the middle of the tenth century onwards it led to the gradual overthrow of Buddhist doctrine and culture by force as well as by propaganda. In the north-eastern portion, however, and in the outlying territory of Turfan, Buddhism continued to flourish much longer, side by side with Manichæism and Nestorian Christianity, under the protection of the Uigurs.

This virile tribe of the Turks, firmly established along the eastern Tien Shan, was the first among their great nation to show capacity for absorbing Western civilization, whether conveyed through Christian or Muhammadan channels. Other Turkish tribes, too, whom bravery and enterprise have carried far away towards Europe, have later on displayed the same capacity, combined with readiness to receive into the national fold and to digest racial elements from conquered populations more advanced in civilization. To these qualities, here only noted in passing

we must attribute the fact that throughout the Tarim basin Turkish is now, and has been for centuries, the only language spoken. Yet the population there, as the anthropometrical materials collected by me and analysed by Mr. T. A. Joyce prove, still retains in the main the fine *Homo alpinus* type, preserved in purity by the Iranian-speaking hillmen of the Pamir region, and shows but slight admixture of true Turkish blood.

It is difficult to believe that from the ninth to the twelfth century the conditions affecting the Tarim basin as a land of passage between Western Asia and China underwent any serious change. It was a time when China, under the weakening rule of the T'angs and then later under the Sung dynasty, was obliged to maintain towards Central Asia a policy of passive defence, if not of rigid seclusion. The north-western border lands passed under the domination, more or less transient, of foreign tribes, whether of northern race such as the Kitan (Khitai) or the Tanguts, who were of Tibetan affinity and established their kingdom along the foot of the Nan Shan. The Khitai who gave their name to *Cathay*, when driven from Eastern Mongolia and the adjoining parts of Northern China moved westwards and by 1126 established their supremacy all along the Tien Shan as far as Samarqand. The Uigurs as well as the smaller states in the oases of the Tarim basin owed them allegiance. Thus the contact with Muhammadan Central Asia which conquests of Uigur and other Turkish chiefs in what is now Russian Turkistan had established long before, was maintained. But in the absence of direct relations with China proper the importance of the ancient trade route leading through the Tarim basin must have greatly diminished.

The phenomenal rise of the Mongols under the great Chingiz Khan, another Napoleon, in the first quarter of the thirteenth century brought about vast changes in political conditions throughout Asia. By the time he died in Kansu, A.D. 1227, his astonishing conquests had brought all countries from the Black Sea to the Yellow River under direct control of the Mongol "Great Khan." The operations continued by his immediate successors ended some thirty years later in uniting the whole of China under the same Mongol dynasty which by its several branches held sway over all Central Asia as far as Persia, and over a great part of Eastern Europe as well. The establishment of one sovereignty across the whole of Asia again cleared the way for direct intercourse and trade between China, the Near East, and Europe. The policy of the Mongol empire distinctly encouraged relations with the Western nations, and thus opened an epoch of free interchange between the Far East and the Far West in commerce, arts, and knowledge such as the world had never known before.

For more than a century the trade routes to the north and south of the Tien Shan saw an undisturbed flow of traffic, and the accounts preserved to us of envoys, traders and travellers then seeking far-off Cathay

from the west tell us a good deal of those routes and of the ground which they crossed. None of those accounts, in accuracy of detail and interest for the geographical student, approach the immortal work of Marco Polo, the greatest of mediæval travellers. The route which he followed in 1273, when on his way from Persia to Kublai's court with his father and uncle, led through the uppermost Oxus valley and across the Pamirs into the Tarim basin. There he travelled by the caravan road between the Taklamakan and the Kunlun to the southern edge of the dried-up Lop sea-bed, and so on to Tunhwang, Suchow, and Kanchow. It has been my good fortune in the course of my journeys to retrace the footsteps of the Venetian along the whole of this route, and to justify by observation on the spot how right Sir Henry Yule, Marco Polo's great modern commentator, was in his implicit reliance on the correctness of Marco's narrative.

The Mongol dominion over China which Marco Polo still saw in its full greatness under the Emperor Kublai came to an end through internal decay within a century of Kublai's accession. The Chinese dynasty of the Ming which replaced it was necessarily bent upon safeguarding the north-western borders against fresh Mongol invasion. They remained exposed to this danger through the continued existence of the Chagatai Khanate along the Tien Shan until the death of Timur, or Tamerlane, and through the subsequent predominance of the Mongol clans of the Oirat in the same region.

Hence a policy of strict seclusion stifling trade once again prevailed on China's marches towards Central Asia. The wall which was erected under Ming rule to serve this close watch of the border still runs, more or less preserved, round the cultivated areas at the northern foot of the Nan Shan. The fortified gate station of Kiayükwan, a day's march to the west of Suchow, marks the place where this wall is crossed by the high-road leading to Tunhwang, Hami, and the Tarim basin.

Of the rigorous watch once kept here over the rare caravans or missions allowed to enter the sacred soil of the "Middle Kingdom," we receive interesting glimpses in the descriptions left us by Shah Rukh's embassy of 1420; by the Turkish Dervish whom Busbeq, the Emperor Charles V.'s ambassador, interrogated at Constantinople between 1555–62, and by Benedict Goës. This devoted Jesuit traveller arrived there in 1606 after a three years' difficult journey across the Pamirs and by the northern road of the Tarim basin. His detention at Suchow for sixteen weary months until death relieved him of all troubles, is proof of the extreme caution with which the admission of foreigners was controlled. That Goës parted only at Suchow "with the last lingering doubt as to the identity in all but name of Cathay and China" is striking evidence how knowledge of the oldest land route to China had faded in the West since Mongol domination had ended.

The rapidly developing use of the sea route to China, following upon

the first Portuguese voyages to India, had long before Goës' time deprived that ancient Central-Asian highway of its former importance for Western trade. Hence the renewed expansion of Chinese power into the Tarim basin which began under the great Manchu Emperor K'anghsi towards the close of the seventeenth century, cannot claim such great interest as that under the Han and T'ang. Yet it deserves here brief mention, be it only as an illustration of the marked influence which unchanging geographical factors must exercise upon historical developments in this region.

This time it was the growing power of the Oirats or Dzungars which forced upon China a fresh advance into innermost Asia. They were Mongolian tribes established north of the Tien Shan in the wide region still known after them by the name of Dzungaria. United under the energetic and ambitious chief Galdan, the Dzungars overawed eastern Mongolia and thus threatened the frontiers of China. The difficult expedition which the Emperor K'anghsi led in person into outer Mongolia ended in 1696 with a signal victory over Galdan. Then Chinese garrisons were first pushed forward to Barköl at the eastern extremity of the Tien Shan. Next by the occupation of Hami the direct route was opened across the Pei Shan desert. Thus protection was secured for the Kansu marches, exactly on the same lines as Chinese "forward policy" had been obliged to follow more than a thousand years earlier against the Western Turks.

The danger from the Dzungars still continued. Their force was impressively demonstrated by the adventurous inroad into Tibet which brought them some twenty years later under Galdan's successor right to Lhasa through Lop, the ancient Shanshan. But it was not until 1755 that renewed aggression by the Dzungars led to expeditions organized by the great Manchu Emperor Ch'ienlung which finally brought the whole of the Tarim basin as well as Dzungaria north of it under direct Chinese administration. Once again, as under the Han and T'ang, a policy purely defensive in its origin had resulted in Chinese expansion over vast Central-Asian regions right up to the Pamirs and the Altai Mountains.

That Chinese control of these regions has continued to the present day, in spite of the growing internal weakness of the empire and the great upheaval caused by the Tungan or Chinese Muhammadan rebellion in the third quarter of the last century, is instructive for the student of political geography. The explanation lies in the fact that for the first time in history China's Central-Asian frontiers had become contiguous with those of a great civilized power, such as the Russian Empire was, capable of dominating the border populations and gradually restraining their nomadic migrations. It was Russia's temporary occupation of Kuldja and the fertile Ili valley which facilitated the Chinese reconquest of the "New Dominion" in 1877, after the Muhammadan rebellion had

flung the Tarim basin for a decennium first into anarchy and later on into oppressive misrule under Ya'qub Beg, a usurper from Western Turkistan. But it was their own organizing capacity which enabled the Chinese to overcome the very serious difficulties of supplies and transport. Thus they gradually moved up troops through the utterly devastated tracts along the northern foot of the Nan Shan and subsequently concentrated them upon Hami across the arid wastes of the Pei Shan.

The times of that "self-determined independence" of the Tarim basin are still remembered with sadness by the people in the oases. According to reliable information I received, the population in some among them had during those times sunk to one-half of what it was before, and it is certain that the cultivated area had everywhere shrunk greatly.

The strings of oases between the Tien Shan and the Kunlun no longer serve a great trade route. So the brave patient camels which carry what traffic there is as efficiently as in the times of Chang Ch'ien or Marco Polo, are not likely to be replaced soon by the rushing motor car or the bustling railway. The traditions of China's great past as a Central-Asian power still protect the peace of the region of which we have followed the fortunes through history. Let us hope they will suffice also thereafter to ward off those troubles and sufferings of which its less secluded neighbour, Russian Turkistan, has had abundant experience during the last few years.

Note on General Map of Chinese Turkistan

This map is based upon the surveys of Sir Aurel Stein and the Indian Surveyors attached by the Survey of India to his expeditions in Central Asia, and published by the Survey of India as an atlas on 1/500,000 *to accompany his 'Innermost Asia,' the detailed report on the last of his three expeditions of* 1900–8, 1906–8, 1913–15. *In the compilation of this material account has been taken of the corrections to be applied to the positions of triangulated points, as indicated by Major Kenneth Mason in Appendix A to Sir A. Stein's 'Memoir on Maps of Chinese Turkistan and Kansu' (Dehra Dun,* 1923), *pp.* 112, 141 *sqq. By permission of Colonel Winterbotham, Chief of the Geographical Section, General Staff, the original compilations for the G.S.G.S. map of Asia on the scale of* 1/4 *Million have been used for most parts outside the range of the Stein surveys.*

Before the paper the PRESIDENT (the EARL OF RONALDSHAY) said: Before I introduce the lecturer you will, I know, desire that I should extend a cordial welcome from this Society to Their Royal Highnesses the Crown Prince and Princess of Sweden, who are honouring us with their presence to-night. We welcome them for the keen interest which they display in the science in which we ourselves are mainly interested, and I might perhaps be permitted to add

that we welcome especially Her Royal Highness amongst us as the daughter of a late member of the Council of our Society.

We are beginning our Session this year with the first biennial lecture upon discovery in Asia, a series which has been established by us, thanks to the generosity of a Fellow of this Society, Mr. P. L. Dickson, and we have been fortunate in securing for the inaugural lecture so distinguished a scholar and explorer as Sir Aurel Stein. Indeed, our lecturer requires no introduction to an audience of this Society, for his geographical work in Central Asia and Western China earned for him the gold Victoria Medal of the Society some fifteen years ago; and the geographical and archæological exploration which he began in Kashmir and the Afghan borderlands more than a quarter of a century ago and which he has carried on at intervals almost ever since in Central Asia and Western China has excited the admiration and the interest of geographers and archæologists the world over. For his lecture this evening Sir Aurel Stein has chosen the subject of the influence of the geography of innermost Asia upon history, and in the course of his remarks he will conduct us to that amazing tract of country which lies south of the Tien Shan Mountains and north of the snowy highlands of Tibet, a vast desert desiccated almost beyond belief and yet the background of rich romance; for it was along this arid and dusty corridor that the civilizations and culture of the West, of India and of the Far East passed and mingled. The long line of communication across hundreds of miles of forbidding desert opened up more than two thousand years ago by the organizing ability of the Chinese has been traced by Sir Aurel Stein in the course of his explorations. He will tell us this evening of many interesting and exciting moments during those days of toil when he was wresting from the sand hummocks of the Tarim basin the secrets of the past. But the height of romance, surely, was reached when the trail of the ancient trade route which he was searching for was dramatically revealed. At one place in a wilderness of salt-encrusted clay he happened upon a scattered line of copper coins of the ancient Han Dynasty of China, covering a stretch of some 30 yards of ground in a well-defined line running from north-east to south-west. How came they there? You can picture for yourselves, I think, the manner of their coming. A caravan of camels travelling silently through the cool of night a little wide of the main track; a hole worn in the sack in which the cumbrous coinage, with which those who have travelled in the interior of China are familiar, was carried; a break in the string on which the coins were strung; the falling to the ground of a few coins with each forward lurch of the camel as it moved on its way: a thing that so easily might happen, resulting in the scattering of a few handfuls of coins, unnoticed, upon the surface of the desert, to lie there until, after the lapse of many centuries, they were to be discovered by our lecturer of this evening. And that is but a single episode in the wonderful story which I will now ask Sir Aurel Stein to unfold to us.

Sir Aurel Stein then read the paper printed above.

The PRESIDENT: Sir Edmund Barrow, whose name has been mentioned by the lecturer, is present this evening, and would like to add a word to the evening's discourse.

General Sir EDMUND G. BARROW: At this late hour I will not detain you for more than a few minutes, but I should like to pay a small tribute to my friend, Sir Aurel Stein. I am brought into contact with this very interesting lecture by the fact that some forty years ago I was a member of a small exploration party under Colonel Lockhart, as he then was, and afterwards

Commander-in-Chief; and part of our duties was to explore all the passes and country in this northerly region of our Empire. May I add, parenthetically, that we were at that time expecting to go to war with Russia, and it was urgently necessary to get information regarding the routes by which India could be approached. The fact of my having been in that part of the world brought me into touch with Sir Aurel Stein twenty years later, or thereabouts, when I happened to be the General commanding on the North-West Frontier at Peshawar. Notices had appeared in the newspapers that a Director of Education for the North-West Frontier Province and Baluchistan had been appointed, and that his name was Mr. Aurel Stein. He was quite unknown to me at that time, but one day I received a card—"Mr. Aurel Stein." He was shown in, and I did not quite know to what I owed the honour of a visit, but in a very few minutes I knew I was in the presence of a most interesting personality who astonished me by his great historical and archæological knowledge of the regions north of the Hindu Kush and the Kunlun. But what surprised me even more was the fact that a Director of Education contemplated making what I knew from my past experiences to be a most arduous and even dangerous journey, and I warned him of the very great difficulties of the routes which lay before him. Being a person of great spirit and enterprise, he was not in the least deterred. For the next two years or so I did not set eyes on Mr. Stein, as he then was. No doubt, the youth of the North-West Frontier Province lost a great deal in the way of education during those two years, but, on the other hand, Mr. Aurel Stein was educating the whole world in very interesting archæological and geographical knowledge—the knowledge of ancient Central Asia.

Sir Aurel Stein was good enough to mention my name in connection with the Darkot Pass and the Baroghil. He mentioned the fact that a certain General Hsien-Chih had actually crossed the Darkot to our side of what is now the Indian border. In his lecture he speaks of this feat as rivalling the exploits of Hannibal and Napoleon. I quite agree with Sir Aurel Stein as to the extraordinary military enterprise that General Hsien-Chih displayed, but I go further and think he *out*-rivalled Bonaparte. I won't trouble you with Hannibal, as it is getting late, and I don't know much about his passage of the Alps. In the first place, you must remember that the passage of the Darkot involved going up to 15,600 feet. The St. Bernard is about 8000 feet, so that the former was double the height of the latter. Moreover, Bonaparte had a made road by which to cross the Alps. In fact, there had been a road there for many years, it having been originally made, I think, about the time of Augustus. There was, in any case, a road with post-houses, and so on, in Roman times. On the Darkot there is not even a path as you approach the top, and certainly from 13,000 feet you are going over soft snow and glacier, and for a good many miles below the snow-line there is the most horrible moraine. How any general could have brought a force of three thousand men over that high and difficult mountain range, I do not know. It was an amazing feat! and the wonder is that he got safely to the southern end, and, more wonderful still, that having got there he was not stopped; because 3 miles up the pass on the Indian side there is a spur which comes out from the main range, and that spur is covered with ancient ruined fortifications. I have often intended to discuss those fortifications with Sir Aurel Stein, because it seems to me that they may be connected with General Hsien-Chih's passage. They are very remarkable, and no one seems to know anything about them. If you ask the inhabitants they say the Kafirs built them, but as they also call us Kafirs, that does not convey much.

I do not think there is anything more I need say. I can only tell you that I have always been filled with the greatest admiration for the exploits of the lecturer, because I know the very great difficulties with which he has had to contend.

The PRESIDENT: The hour is late, and I will therefore not invite others to speak. For the same reason I do not propose to add anything myself. I only desire to assure Sir Aurel Stein that the manner in which he has wrested the secrets of the past from the shifting sands of the Taklamakan Desert and from the salt-encrusted wilderness of the dead Lop Sea has excited out highest admiration. I think I can safely assure him that Mr. Dickson, who is unfortunately prevented from being here to-night, will be deeply gratified when he reads the first of the Asia lectures which he has so generously endowed.

THE DETERMINATION OF GRAVITY AT SEA IN A SUBMARINE

Dr. A. F. Vening Meinesz

Read at the Afternoon Meeting of the Society, 20 April 1925.

IT may be expected that the determination of gravity at sea will give important contributions to many scientific questions concerning the figure of the Earth and the constitution of the Earth's crust, and it therefore has already several times been the subject of experiments. The first valuable observations were made by Hecker, who from 1901–1908 made voyages in the Atlantic, Indian, and Pacific Oceans. He applied the method indicated by Mohn of determining simultaneously the pressure of the air in two different ways, by the ordinary mercury barometer and by the boiling-point of a fluid. The first of these methods gives a result which depends on the intensity of gravity, and the second a result which does not, so the comparison of the two gives the desired intensity of gravity.

Hecker's observations led to the important general conclusion that in the mean gravity at sea does not deviate much from the normal value. It was however not yet possible to attack successfully the majority of the problems under consideration, as for that a greater accuracy of 1/100,000 or 1/200,000 is necessary. This paper is an account of a new endeavour in this direction, made during a voyage from Holland to Java, which has given satisfactory results, as the accuracy seems to comply with this requirement.

After studying the subject it seemed that an improvement of Hecker's method or of another statical method, to give a considerable reduction of the mean error, would present great difficulties. This opinion has since then found support in the recent publication of the experiments of Prof. Duffield, in spite of the admirable skill which he brought to bear on the application of these methods.

On the other side there seemed reason to doubt the general opinion

that pendulum observations would be impossible on the sea, and as experiments on land have always confirmed the superiority of this dynamical method above the statical ones, it was worth while to investigate this question. The facts which have brought about these considerations originated in the difficulties which were met during the execution of gravity observations in Holland. The instability of the ground in the whole western part of the country made it impossible to find a firm foundation for the pendulum apparatus; it appeared that these microseismic movements are not restricted to the neighbourhood of roads with heavy traffic, but are found everywhere. The movements seemed further to depend on the strength of the wind, and to increase near the coast of the North Sea, so that it is supposed that they are caused by the action of the waves. As it was impossible to avoid these movements, the solution was sought and found in another direction, namely, in the elimination of their disturbing effect on the pendulums by observing at the same time two pendulums swinging in different phases. This method proving quite successful, it was obvious to apply the same idea to the problem of the determination of gravity at sea, and the sole question was, if the method could be extended in such a way that the effect of the much larger movements of the ship could also be eliminated. This proved to be possible, provided that these movements are small, the angular deviations for instance not exceeding 1°; otherwise a great many secondary disturbances would become too big to be managed. It was moreover at once clear, that this would be also necessary for the practical execution of pendulum observations, for each pendulum swings with a knife-edge on an agate plane, without any lateral support against sliding.

Taking advantage of the valuable advice of Prof. van Iterson, it was found possible to realize these conditions even during bad weather by making the observations on board of a submerged submarine. This makes the observations nearly independent of the state of the sea, which naturally is a great advantage.

After experiments on a Dutch submarine in the neighbourhood of the harbour of Helder, which gave satisfactory results, the Dutch Geodetic Committee resolved to put the method thoroughly to the test during a longer voyage. The departure in September 1923 of three submarines of the Royal Dutch Navy for Java offered a good opportunity; by consent of the Minister of Marine the writer was allowed to join one of the boats, the K II, and so a great many observations could be made in different circumstances. Before enlarging upon this voyage, a short description of the method may be given.

The movement of a pendulum on a mobile support is a rather intricate subject. The disturbances may be brought under three heads: those caused by the horizontal accelerations of the point of suspension, those caused by its vertical accelerations, and those caused by the angular movements of the support. Theoretical considerations as well as practi-

cal experience during the voyage showed that the influence of the horizontal accelerations is by far the greatest. It is, in fact, due to this cause that the pendulum's movement is so very irregular on a ship. This disturbance may however be eliminated completely by swinging two pendulums together in the same plane on the same support, so that the horizontal accelerations may be considered to be equal. For isochronous pendulums this elimination is simple: the difference of the elongation angles θ_1 and θ_2 of the two pendulums may be regarded as the elongation angle of an undisturbed pendulum.

The amplitude and the phase of this hypothetical pendulum may be deduced by introducing for each pendulum a vector representing its movement. This vector has a length equal to the amplitude and rotates with a constant angular velocity if the pendulum is undisturbed; the projection on a horizontal axis represents the elongation angle of the pendulum. A simple consideration shows that the vector representing the movement of the hypothetical pendulum is the difference between the vectors representing the two original pendulums. As those vectors may be deduced from the record, the vector of the hypothetical pendulum is also known, and so we get the amplitude and time of oscillation of the hypothetical pendulum, which is free from disturbance by horizontal accelerations.

The other disturbances are much smaller; observations have shown that only two of them are perceptible, at least for the small movements of a submerged submarine: the influence of the vertical accelerations, and the effect of the rocking of the plane of oscillation.

The first influence cannot be eliminated, as the vertical accelerations of the boat are indissolubly connected with the acceleration of gravity, so that elimination of the former would imply elimination of the latter, but it may be shown that the result for g is affected only by the mean value of this vertical acceleration during the whole time of observation. Since the vertical acceleration is fluctuating about zero, this mean value is small and is in fact equal to the difference in vertical velocity at the beginning and at the end of the observation, divided by the duration. It may therefore be reduced indefinitely by increasing this duration or by taking the mean of a great many moments for the beginning and for the end of all the observation.

The second disturbance, the influence of the rocking of the plane of oscillation, is caused by the fact that we do not measure gravity itself, but the component of gravity in this plane. By recording the rocking angle the correction may easily be computed.

The other disturbances appear to be negligible; for several of them theory shows that they must affect the amplitude as well as the time of oscillation, so the fact that the amplitude of the hypothetical pendulum is quite regular implies their negligibility.

The observations were executed with a Stückrath apparatus con-

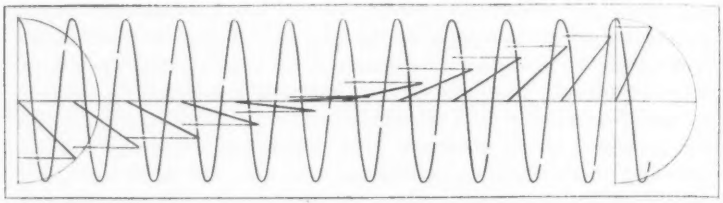


Fig. 1.—Diagram of photographic record of one pendulum on a fixed support.

The breaks in the record made each record by the chronometer are followed after half a second by breaks caused by the return of the occulting mechanism.

The figure shows the construction of pendulum vectors corresponding to whole seconds. Such a vector describes 180° in the time during which the pendulum loses one oscillation on the chronometer. The period of the pendulum can therefore be derived from the angular velocity of the vector.

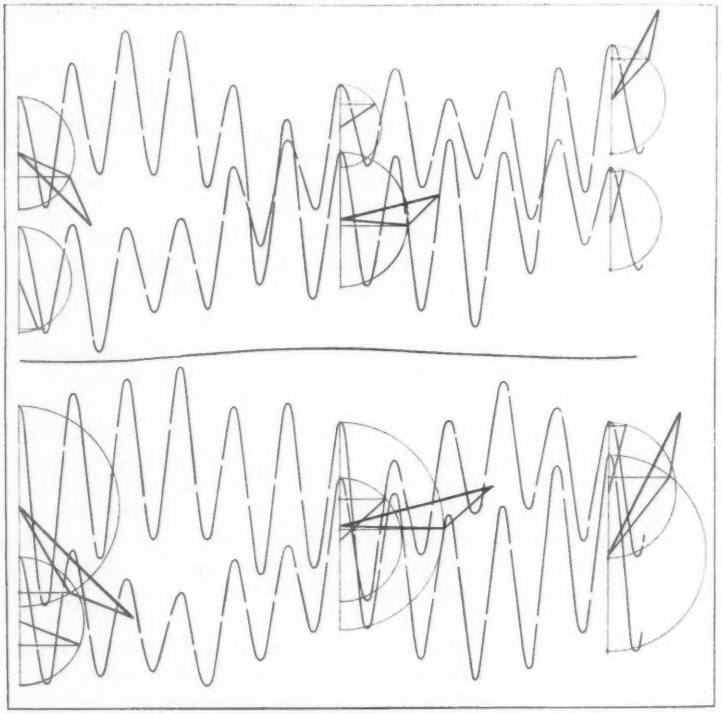


Fig. 2.—Diagram of complete record of four pendulums.

The vectors of a pair of pendulums in the same plane being combined, the resultant is free from disturbance caused by the horizontal movements of the support, and the angular velocity of the resultant vector gives the period of oscillation for the hypothetical undisturbed pendulum.

The divergence between the records of one pair gives the inclination of the plane of oscillation of the other pair, from which the correction to the time of oscillation is computed.

In practice the graphical construction is not carried out, but the computations are made from measurements.

taining four half-second pendulums swinging by pairs in the same plane. The two planes of oscillation are perpendicular to each other, and the apparatus was placed so that these planes made angles of 45° with the axis of the boat. The four pendulums swung all together and were recorded photographically; this was necessary because the method requires the observation of the pendulums at exactly the same moment. For each pendulum the record was effected by a ray of light reflected in a little mirror of the pendulum perpendicular to the plane of swing and parallel to its vertical axis. By a system of fixed prisms and mirrors the four recording rays were all directed towards the same recording apparatus, placed at a distance of 4 feet in the axis of the boat, and containing a horizontally moving band of photographic paper.

It may easily be seen that it was not necessary to make a special record of the rocking of the apparatus, as this quantity is given by the pendulum records themselves: the rocking of one of the planes of oscillation is the same as the shifting of the vertical in the second plane (which is perpendicular to the first), and this shifting of the vertical gives a corresponding deviation of the records of the pendulums swinging in this second plane. In the same way the deviation of the records of the pendulums swinging in the first plane of oscillation gives the rocking of the second plane.

The execution of the observations met with several practical difficulties. The interior of a submarine is not the most favourable spot for scientific observations, and besides the material difficulties there often arose some rather queer situations. Without the whole-hearted assistance of the Commander, Lieut. L. A. C. M. Doorman, of the other officers, and of the crew the observations would have been more difficult and would not have given the good results they did give. To lessen the accelerations caused by the rolling and pitching the apparatus was put in the axis of the boat and as near as possible to the metacentre. This implied its being put in the steering-room, which during submergence is extremely crowded. Besides the helmsman and the men who handle the two horizontal rudders, there are at least two officers, some men for the valves which control the tank-pumps, and last but not least the cook with his electrical furnace, who always pursued his labour with undisturbed coolness (in a figurative sense!). In fact, during submergence there is not much space for movement in the steering-room, even in the eyes of a submarine inhabitant, who is not exactly spoiled in that direction. The temperature generally becomes high—in the Red Sea it rose to about 100°—and the air is moist and often nearly saturated. The black cloth covering the two instruments for shutting off stray light, under which it was often necessary to kneel to control the proper working of the apparatus, did not make things better. It thus was a decided advantage that the pendulums were recorded photographically, as personal observation would inevitably be influenced by circumstances.

The quick increase of temperature was not favourable for the accuracy of the observations, as it naturally makes the temperature of the pendulums somewhat uncertain. This would not have been serious if invar pendulums had been used, but for fear of the influence of the magnetic field, which may be expected in a submarine, the observations were executed with brass pendulums, which vary much more with the temperature. It appears easily possible to avoid this cause of error in the future, either by isolating the apparatus, *i.e.* by keeping it at nearly constant temperature, or by using quartz pendulums, which unite the advantages of independence of temperature and magnetism. The apparatus had to be mounted on a wooden floor, so that the fixing was not very satisfactory. To lessen the dangers of disturbance by walking to and fro past the apparatus, the commander always gave orders to the whole crew to keep still during the observations; this gave the further benefit of avoiding extra movements of the boat by the disturbance of equilibrium.

A very marked advantage of a submarine for this work is the fact that during submergence it is moved by electromotors, which cause only very small vibrations in the boat. After trial a velocity of $4\frac{1}{2}$ miles per hour was chosen; for this velocity the vibrations were imperceptible. It is not possible to stop the engines, as a submarine needs horizontal velocity to maintain itself at a given depth by the horizontal rudders.

To determine the rate of the chronometer, radiotelegraphic time signals were received. As far as Alexandria the signals of Paris were used; as they became then suddenly inaudible, Lyons was taken afterwards; but in the neighbourhood of Ceylon these signals also disappeared in a rather sudden unexpected way, and for the last part of the voyage the signals of Calcutta were used. The two first stations send rhythmic signals, which could easily be taken with an accuracy of a few hundredths of a second, but the reception of the Calcutta signals, which are of the ordinary kind of a few dots, was not so accurate, as there were no means to record them.

The presence on board of a sound-wave signalling apparatus for getting connection with other ships while submerged proved to be of advantage for sounding the depth of the sea, as the echo of the signals could always be clearly heard even for the greatest depths of some 2500 fathoms which were passed. As there was no special mechanism, the time-interval was simply taken with a stop-watch; in this way the depth was obtained with a mean error of some 50 fathoms. It is very important to have a rough depth-record to supply the necessary data for judging the results for gravity, and so it was necessary to make these observations for those parts of the voyage where the depth was not known from the charts. It seems desirable to develop this further in the future, and to use modern echo-sounding apparatus to make a continuous and more exact profile of the sea-bottom during the voyage.

The first part of the voyage from the Helder to Gibraltar was not fortunate. During the first five days the sea was very rough, which makes life on a submarine, rolling some 30° to 40° to each side, and pitching a corresponding amount, somewhat picturesque. It was disappointing to find that even at a depth of some 20 fathoms the movements of the boat still exceeded considerably the limit of 1°, above which the successful execution of the observations becomes impossible. The pitching was small enough, but the rolling attained some 2½° to each side.

This result was got during a heavy swell of the Atlantic with a wave-length of some 300 yards. Afterwards in the Indian Ocean, with a newly disturbed sea, also very heavy but much shorter waves, the boat was very quiet at a depth of 10 fathoms. This dependence on the wave-length is quite in harmony with the theory of wave-movement.

In this way the greatest part of the first stretch of the voyage was lost for the observations; only during the last calm days a few observations could be made south of the Spanish coast.

At Gibraltar a week of rest was used for constructing a cradle for the apparatus to make the observations less dependent on the state of the sea. This was executed at the British Naval Construction Establishment, where the authorities kindly gave all the desired assistance. The cradle could oscillate only along one axis, which was put in the length direction of the ship. This was quite sufficient, as the pitching during submergence never exceeded the limit. The cradle reduced the rolling of the apparatus so much that afterwards observations were always possible.

The voyage in the Mediterranean was prosperous; the boat stopped some days in Tunis and in Alexandria. In the Red Sea the heat became somewhat disagreeable, although the time of the year, November, was favourable. After a stoppage at Aden the voyage was continued to Colombo, which was the longest uninterrupted passage. The weather was fairly good during the crossing of the Indian Ocean; only during the first part there was a long swell, which would again have given difficulties for the observations if the cradle had not sufficiently neutralized the rolling effect. From Colombo the K II made a small extra détour southward of Ceylon to execute observations on the edge of the continental shelf, which is very steep there. Afterwards the track lay straight to Sabang, on a small island north of Sumatra, and thence through the Straits of Malacca to Batavia.

We obtained two sets of observations before Gibraltar, south of the Spanish coast, two between Gibraltar and Tunis, three between Tunis and Alexandria, one between Alexandria and Port Said, four between Suez and Perim, seven between Socotra and Colombo, four between Colombo and Sabang, and three between Sabang and the Strait of Malacca. Control observations were made in the harbours of Tunis, Alexandria, Suez, Aden, Colombo, and Sabang.

The results of the observations have been satisfactory. There was not the slightest trace of any slipping of the knife-edges on the agate planes of the support; this was a very important result, as slip would have destroyed all possibility of success, because then the supposed equality of the motion of the knife-edges of the two pendulums of a pair would not have been true. Secondly, many secondary disturbances appeared to be negligible, as has been told already; this gave a considerable simplification in the computations and enhanced the accuracy, as the elimination of some of them would have caused great difficulties.

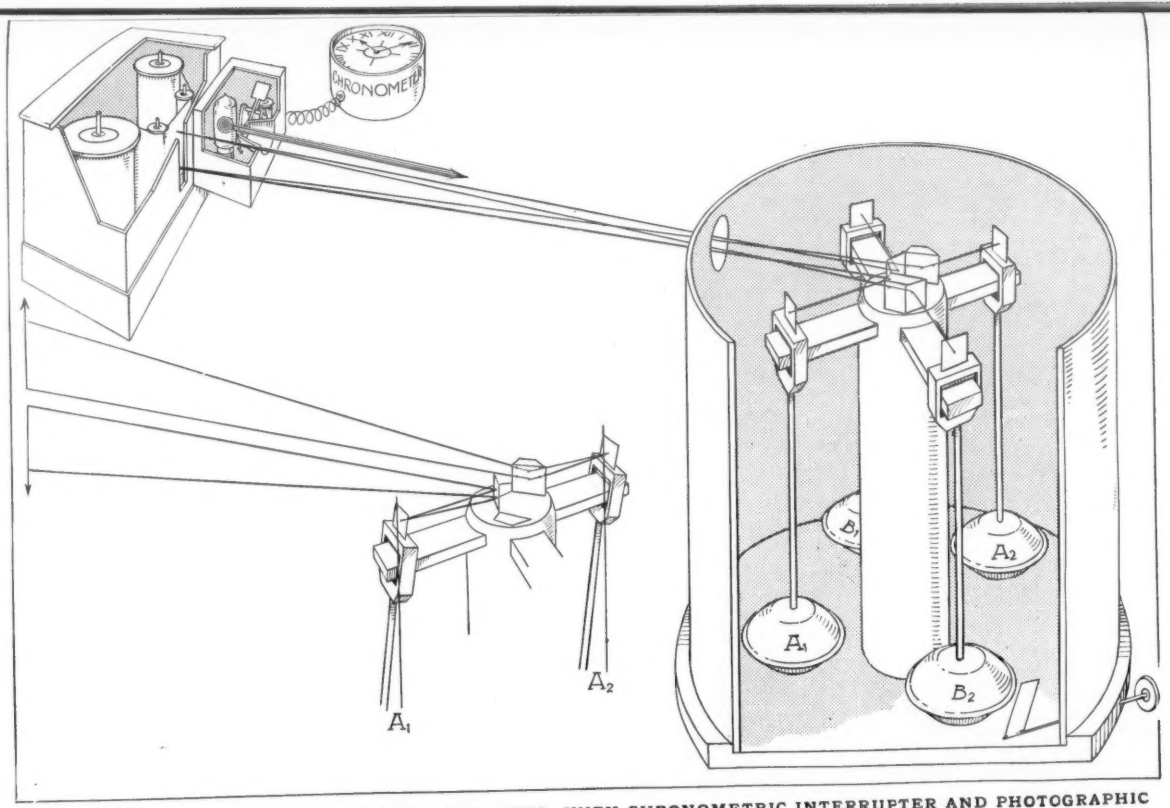
Thanks to this fact the accuracy surpassed expectations; it may be estimated at 1/200,000 of the intensity of gravity, that is about half of the accuracy of land observations. The difference is not caused by the disturbance through the movements of the ship, but by secondary influences, such as the uncertainty of the temperature, of the rate of the chronometer, and the velocity of the ship in the direction of the parallel.

The first question has already been mentioned; it may be hoped that in the future this cause of uncertainty may be reduced.

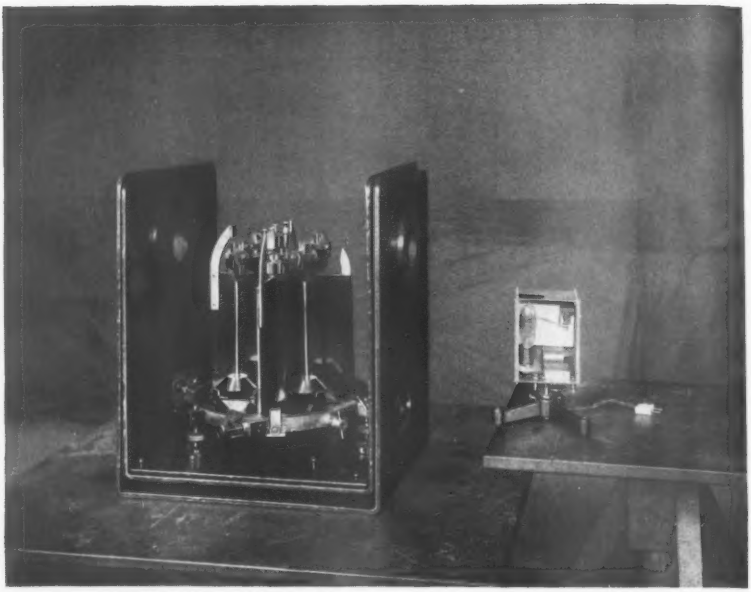
The second question is more difficult to manage; it has not its origin in the inaccuracy of the time-signal reception, which is quite sufficient, but in the possible difference of rate during the observation, which takes about twenty minutes, and the mean rate between two time-signals, which often are twenty-four hours apart. The simplest way of getting more security against serious errors by this cause seems to be to take along more than one chronometer, but this cannot take it quite away. A thorough amelioration seems difficult, as it could only be got by time-signals which are a short time apart, combined with an extremely accurate reception method, or by prolonging the observations over a much longer time. This last possibility will generally give practical difficulties, as the ship ought then to stay all the time at nearly the same spot.

The third question—the influence of the velocity of the ship in the direction of the parallel—has its origin in the change in the centrifugal force of the Earth rotation, because this velocity is added to or subtracted from the velocity caused by the rotation. It was von Eötvös who first drew attention to this effect *à propos* of the observations executed by Hecker. It offered a nice possibility of controlling the accuracy of the observations by making at the same spot two observations, one with eastward and one with westward velocity. The results were satisfactory, as they did show a decided difference, which coincided exactly with the computed amount; in fact, the velocity of the ship deduced from this difference corresponded within half a mile per hour with the actual velocity deduced from the number of revolutions of the screw. The experiment was repeated afterwards three times with the same result.

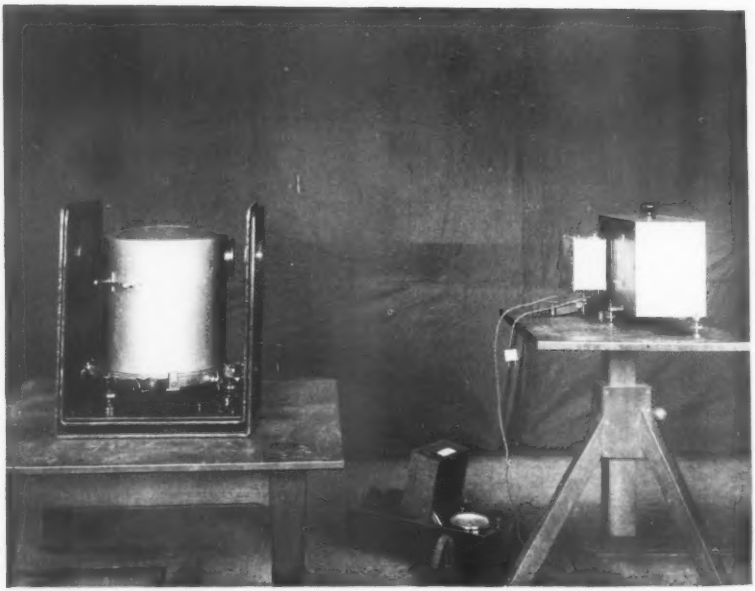
The drawback of this question is, that for the computation of the correction which has to be applied to reduce the observation to zero



1. DIAGRAM OF DR. MEINESZ' PENDULUM APPARATUS, WITH CHRONOMETRIC INTERRUPTER AND PHOTOGRAPHIC REGISTRATION



2. THE PENDULUM CASE OPEN, AND THE LAMP WITH OCCULTING MECHANISM



3. THE PENDULUM CASE COVERED, LAMP IN POSITION CONNECTED TO CHRONOMETER, AND PHOTOGRAPHIC RECORDING APPARATUS

velocity, it is not only necessary to know the velocity of the ship with regard to the water, but also the current. This is a difficult matter, as the current has to be deduced from the astronomical observations which are far apart, so that a mean value during this whole time-interval is found. This value may easily deviate from the value during the observation, especially as the current at the depth at which it is made may differ from the current at the surface. To give an idea of the magnitude of this influence: a velocity of one mile per hour causes at the equator a deviation of $7\frac{1}{2}$ millionths of gravity.

Theoretically it seems possible to determine the desired eastward velocity component by a gyroscopic apparatus, but this will certainly give numerous practical difficulties. This question is still being studied. It may further be remarked that obviously this cause of error is not dependent on the method described for the determination of gravity at sea, but is inherent in all experiments made on board a ship.

Of the results of the voyage the values in the Indian Ocean are the most interesting from a general point of view. They show two important features: firstly, they are very regular, and secondly, they are nearly normal; that is to say, that the part of the Indian Ocean between Socotra and Sabang seems to be in almost complete isostatic equilibrium. In the greatest part the deviations are of the order of the mean error; in the western part, *i.e.* west of 62° east of Greenwich, the two observations which were made there show small positive deviations: +0·012 cm. and +0·021 cm.

For the normal value was taken here the gravity formula of Helmert of 1901. The results are already isostatically reduced by Mr. Bowie, of the U.S. Coast and Geodetic Survey, *i.e.* they have been freed from the attraction of all the masses above sea-level on the whole Earth surface and of the corresponding compensating masses below that level as supposed by the theory of isostasy. In this way the remaining deviation is really caused by deviations from isostasy, and not by other features. This labour has still to be done for the other observations of the voyage, so that final conclusions are not yet possible. Provisionally, it may be said that the results have not shown any strong unexpected deviations; only the value found above the base of the steep continental slope south of Ceylon seems to show a remarkable positive anomaly, if at least the very rough provisional computation of the attraction of the shelf is not far wrong. The value above the upper edge is normal as far as can be seen. Both facts need confirmation by the final computation before any conclusion can be drawn.

It appears worth while to pursue these investigations. There are several problems to which the determination of gravity at sea may contribute. We may first name the chief object of geodesy: the determination of the figure of the Earth. Gravity observations on land have already made an important addition to the data given by triangula-

tions. The last most thorough computation, based on more than two thousand values of gravity, was executed and published in 1915 by Helmert. He found, curiously enough, that these values correspond a little better to an ellipsoid with three different axes than to a solid of revolution. It is true that, as he remarks himself, the difference in correspondence is not great, but there were some features of the computed results which caused him to give a decided preference to the triaxial form. He finds a difference in the axes of the equator of about 500 metres.

This shape appears not to be in harmony with present conceptions regarding the constitution of the Earth. It is generally accepted that below a relatively thin layer of some 60 miles the materials of the Earth's crust begin to show the properties of fluids with a very high viscosity; under stresses acting during a short time they behave like solids, but when the stresses are continuous they give way even when the stresses are small. If this opinion is correct—and all experience tends in that direction—the Earth up to the outer rigid layer ought to assume the form of a solid of revolution.

If, further, this outer layer is floating on the interior as the theory of isostasy demands, the attraction exerted by this outer layer may be computed, and as only this part of the total attraction can give a deviation between the geoid and a solid of revolution, this deviation may be deduced. The result is only a very small difference between equator and circle, which is not at all sufficient to explain Helmert's result.

It appears to be of fundamental importance to investigate this thoroughly, to see if Helmert's longitude term in gravity is really according to the facts, because this would imply the necessity of reviewing our theories. It may be expected that the gravity determinations at sea will provide means to do so; besides supplying values for the great stretches of Atlantic and Pacific Ocean, which are now missing in the gravimetric survey, it may be hoped that, thanks to the regularity of the results, a relatively small number of values will be sufficient and will give a clearer result than the land observations.

It is indeed not improbable that this regularity will be a fairly general feature of gravity at sea. The irregularities on land are chiefly caused by local deviations in the density of the Earth-crust in the near neighbourhood of the gravity stations, and in the ocean these irregularities are at least a few miles further off. Besides, the sea-bottom may be, as some geologists suppose, more homogeneous than the upper layers of the continents, and this would still more emphasize the regularity of gravity. It seems an important result of the voyage to Java, that in the Indian Ocean this regularity is so marked, that there the above expectations have been fully confirmed. The sea observations will further make it possible to establish if there is a systematic difference in gravity between the oceans and the continents, which might be the case, although it is not

probable. In that case a determination of the geoid from the land observations alone would be erroneous, and the ocean values would form a necessary complement.

There is still another reason why it appears desirable to get a decision about Helmert's result in relation to the modern views about the Earth's constitution. Accepting the hydrostatic equilibrium of the earth-interior below the outer layer of 60 miles, Prof. W. de Sitter of Leyden has made a computation of the flattening of the Earth, based on the lunar precession. He found a value of $1/296{\cdot}9$ with an accuracy which seems to be greater than may be got at any time by other geodetic operations. If the starting-point about the hydrostatic constitution of the Earth is confirmed, as seems to be probable, it appears reasonable to take the value of the flattening found in de Sitter's way as a fixed base for further geodetic determinations. The chief aim of geodesy might in this way be shifted to the determination of the deviation of the geoid from the shape which the Earth would assume if the outer layer were also fluid, or, in other words, to the investigation of the influence of the constitution of the outer Earth-crust.

It thus seems desirable to attack without delay the problem of the shape of the equator. It may be surmised that there are three different possibilities for gravity along the equator: a longitude term corresponding to an elliptic equator; a constant value corresponding to a circular equator with local gravity deviations, which in Helmert's computation would have cooperated accidentally in giving his result; and a constant value with extensive deviations. It is clear that this last possibility could more easily have caused Helmert's result than the second one; at the same time it would be possible to bring it in harmony with the hydrostatic constitution of the Earth, as its cause could be restricted to the upper rigid layer. It would, however, be a very important result with regard to the investigation of this layer, as it would reveal widespread actions in it.

This question brings us to the second series of problems on which gravity observations throw some light, *i.e.* the problems relating to the Earth-crust. It is well known that already long ago the determination of the deflections of the plumb-line have brought Pratt to the formulation of the thesis of *isostasy*, a name which was afterwards introduced for this phenomenon by Dutton. Gravity observations have since then corroborated this evidence nearly everywhere. The hypothesis says that the excesses of mass present above sea-level are compensated by defects of mass between this level and a plane of compensation, which is now estimated to be at a depth of about 60 miles, or, in other words, that the total mass contained by vertical cylinders of equal cross-sections, reaching to the plane of compensation, is everywhere the same. Already in 1855 Airy gave an explanation of this phenomenon by supposing that the materials of the Earth-crust have the properties of

fluids beneath a certain depth, and that the crust is therefore in floating equilibrium like a field of icebergs on water.

It is obviously desirable to ascertain if this principle of isostatic equilibrium is also valid on the oceans. It is clear that with the present conceptions about the Earth-crust, it is highly probable that in a general way this will be the case. The results of the observations of Hecker and Duffield, as well as those found during the voyage to Java in the Indian Ocean, have all confirmed these expectations. Still, further material will be welcome.

But besides stating the general principle, it seems important to investigate if there are deviations of the isostatic equilibrium, as these would throw light on many geological problems. There are two explanations possible for equilibrium disturbances: Firstly, the strength of the upper layer of the Earth-crust is so great, or the plasticity of the layers beneath is so small, that the Earth-crust is able to maintain indefinitely a disturbance of equilibrium; or, secondly, the Earth-crust is not able to maintain disturbances, but the disappearance is effected so much slower than the action of the causes of this disturbance, that it cannot at once annihilate their effects.

Possible causes of equilibrium disturbances in the Earth-crust are, for instance, erosion, sedimentation, the transport of dense volcanic material to the surface by eruptions, the formation of ice-masses on the surface, possibly the presence of tangential stresses in the Earth-crust, as for instance the contraction theory supposes, possibly also deformations of the Earth-crust as mountain folding or thermal phenomena, etc. Gravimetric survey may by investigating the isostatic equilibrium prove the absence or presence either now or in the past of one of these causes.

Now the oceanic observations, besides giving data for the investigation of a great and still only slightly known part of the Earth's crust, which may perhaps present a systematic difference from the continental crust, have two other features: firstly, the results will probably be more regular, so that surer conclusions concerning essential disturbances of the isostatic equilibrium may be anticipated; and secondly, two causes of disturbance may be dismissed, as there is no erosion and only a small sedimentation going on; it may therefore be hoped that the interpretation of the equilibrium deviations may be easier.

It is to be expected that by this investigation new facts will be gathered which may throw light on the tectonic hypothesis concerning the Earth's crust. A few examples may show in which direction, for instance, decisions may perhaps be got.

Taking first the hypothesis of Mr. Bowie, who considers that the only causes of disturbance of equilibrium are erosion and sedimentation. These disturbances would cause vertical movements in the Earth-crust for the recovery of equilibrium, and this would give cooling or heating of the rising or descending materials resulting in thermal changes of volume,

which present a second cause of vertical movements in the Earth-crust. In this way the alternating upheaval and subsidence of geosynclines is explained. The principal point in relation to our subject is, that in the oceans erosion and sedimentation are practically absent, so that, as the only disturbance cause does not come into action, there ought to be nearly perfect isostatic equilibrium on the oceans.

If the contraction theory corresponds to the facts, extensive deviations of equilibrium might be possible. If there are strong tangential stresses in the Earth-crust, these stresses will cause a disturbance of the isostatic equilibrium, and it would not be improbable that these disturbances showed themselves first chiefly in the oceans, as there the action of the water will facilitate an upward movement. This would imply extensive positive gravity anomalies there. The explanation which this theory gives, that the foldings of the upper crust-layer, which come to pass when the stresses become too big, do not occur in the oceans but in the continents, although the upward tendency has been greatest in the first, may be left out here as it has no importance for our subject.

The version of the contraction theory given recently by Mr. Harold Jeffreys in his remarkable book 'The Earth' supposes a different mechanism in the crust under the oceans. According to his view the Earth's crust tends to bend because of the cooling of the deeper layers, and as this cooling is going on more quickly under the oceans than in the continents, this bending is taking place chiefly in those parts of the crust first. The oceans ought then to show positive gravity anomalies in the rising centre part, and negative ones above the borders, where the bending shows itself in the formation of deeps.

Another theory about the Earth-crust, advocated by Wegener, supposes that the crust is not a rigid whole, but that only the continents are rigid, and that they are floating in a slightly plastic denser layer composed of "sima." This layer would therefore form the bottom of the oceans. If this view is right, the sea-bottom ought either not to show big topographic irregularities, or, if they are present, they ought to be temporary disturbances in equilibrium by some cause such as 'the horizontal displacement of floating continents or isles, and in the long run they must disappear by flowing away. This explanation would imply deviations of isostatic equilibrium, that is to say, isostatic anomalies of gravity, showing a decided parallelism with the topographic features of the ocean-bottom. It may be conceded that elevations above the normal level could be explained otherwise, for instance, by the floating of lighter material in the layer of sima or by deviations of homogeneity in this layer, and thus could be in isostatic equilibrium, but for all the features of the ocean-bottom below the normal level, the above reasoning ought to be valid, as isostatic compensation of those features would imply excesses of mass, which cannot be there as they must sink away in the

sima layer. Especially gravity observations above the great ocean deeps will throw light upon this question, as there the deviation must be very marked.

Another point of interest would be to make an extensive gravimetric survey above the edge of the continental shelves. If Wegener's hypothesis ho'ds true, there is there a sudden change in specific gravity of the crust materials, which probably will reveal itself in the gravity field. But also from the point of view of other theories these observations will be interesting. If there is a systematic difference between the constitution of the continental and the oceanic crust, it may be expected with due reason that this will show itself in the clearest way on the boundary between the two. It must however be kept in view that in order to take account of the effects of the topographic features of the shelf, it will be necessary to have an accurate chart of the neighbourhood. This is a general remark applicable to all gravimetric results, but it is the more necessary for the observations where the topographic irregularities of the sea-bottom are near and very marked. It cannot be gainsaid that perhaps this question, combined with some uncertainty regarding the density of those irregularities, will sometimes give difficulties for the interpretation of the results of the gravity observations, and it must therefore be deemed important to accompany the determinations in the future with frequent soundings to lessen this cause of uncertainty.

The writer is fully aware that the remarks about the possible conclusions which may be expected from the results of gravity observations at sea are superficial and problematical and are surely not complete, as the subject is not easily exhaustible. However, a more serious consideration of the different geophysical theories in relation to gravity at sea would take too long and would not be justified, as it concerns only rather vague anticipations. It is quite possible that the results which will be got in the future will lead to other interpretations and a different line of investigation. But even if this should be the case, it seems not doubtful that important data will be obtained for a great number of these scientific problems, and it was only to make this fact acceptable that the expectations were mentioned. It is to be hoped that the investigations will be soon taken up by many countries, and that before long a sufficient number of results will be available for the attack on these problems.

Before the paper the PRESIDENT said : We are indebted this afternoon to Dr. Meinesz, the Executive Officer of the Geodetic Survey of Holland, for coming to lay before us the result of his experiments in determining gravity at sea in a submarine. The principle of a pendulum survey on land has been in operation in various parts of the world, and the Survey of India in particular have made much use of it ; but it has been left to Dr. Meinesz, I believe, to discover a method of applying this principle at sea. It was owing to the instability of the surface of the land in Holland that he arrived at a method of counteracting the incidental motion which is inevitable, of course, at sea

and which tends to invalidate the work of the pendulum. He discovered that these incidental motions could be discounted by the use of two pendulums swinging in different phases. It then occurred to him that this principle might be made use of on board ship, but the motion on the surface of the sea was too great, and in order to eliminate the effects of it he went below the surface in a submarine, and put his principle of making use of two pendulums into operation below the surface of the sea. I have much pleasure, therefore, in asking Dr. Meinesz if he will give us the results of this very interesting experiment which he has successfully carried out.

Dr. Meinesz then read the earlier part of the paper printed above, and a discussion followed.

Colonel Sir GERALD P. LENOX-CONYNGHAM: Dr. Vening Meinesz has given us a very clear account of his method and of its applicability to observations made at sea on an unsteady platform, but I should like to add that the value of his method is not confined to observations made at sea. As the President told us, Dr. Meinesz was forced to study this matter by the instability of the soil in a large part of Holland. That instability, of course, is not found in very many places, but all pendulum observations suffer from instability, not existing in the soil on which the apparatus is erected but imposed on the apparatus by the moving pendulums themselves. Whenever an apparatus is put up and the pendulum set swinging, the whole apparatus begins to sway with the pendulum and that introduces an error. It was because the means of measuring that effect had not been invented that so much of the, in other respects, most admirable work done of old by Sabine and Kater and in India by Basevi and Heaviside has been deprived of much of its value. In those days there were no means of measuring the sway correction, and indeed I think its importance had not been recognized. Means have since been invented for measuring that error and correcting it, but they have hitherto involved a separate operation, or a separate piece of apparatus. In Europe the plan has been, generally, to make a separate observation: by observing how quickly a pendulum at rest takes up a swing from another set in motion on the same stand a measure of the instability is obtained. In America it is mostly done by an interferometer method, by which the actual to-and-fro movement of the stand is measured. Both are somewhat troublesome, and the correction to the time of oscillation has then to be computed by a formula which is at best an approximation. Dr. Meinesz's method gives a direct result which is quite free from the effect of any such sway of the stand, so that his method is of great value for land observations as well as for sea. I think, therefore, that he has made an important addition to the means at the disposal of pendulum observers for the determination of gravity.

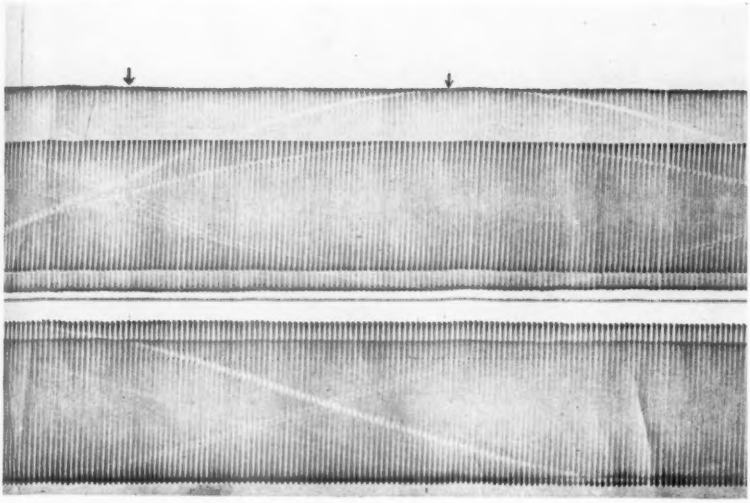
The three troubles in such determinations have been temperature, determination of time, and instability of stand. The temperature difficulty on land can be got over to a considerable extent by using invar pendulums. Time has been greatly improved by wireless telegraphy, and now Dr. Meinesz has removed almost altogether the bugbear of the instability of the stand. In my opinion his method should be adapted for all gravity surveys, not only for those made on board ship. But the value of being able to determine gravity on board a ship is very great indeed. Hitherto all efforts to do so have been comparative failures. Some results have indeed been obtained, but the probable error has generally been greater than the quantity sought for, so that no certain conclusions could be based on the observed values. I think we

may now rely completely on the results given us by Dr. Meinesz or others using his method, and I hope that the problem of determining gravity at sea has been solved.

Lieut.-Colonel H. McCALLY COWIE, R.E. (Survey of India): Dr. Meinesz's description of the methods and apparatus which he has used to eliminate automatically the effects of sway and instability of stand from the times of oscillation of the pendulum have been of special interest to me, because at this time I have under consideration the design of a new pendulum apparatus for the Survey of India. The conditions in Holland which made imperative the adoption of a method of eliminating the effects of flexure appear to exist also in part of India—in the Brahmaputra–Ganges delta. In Calcutta, for example, Colonel Sir Gerald Lenox-Conyngham found that the surface tremors were of such a nature that it was impossible to obtain reliable results with a half-second pendulum. Whether these surface tremors are local phenomena peculiar to Calcutta, or whether they are of more extensive regional nature is not yet known. The area affected by these surface tremors has not been defined. That, I hope, will be one of the problems which the Survey of India will take up for solution in the near future. But in order to be able to obtain times of oscilation free from the effects of flexure and instability of stand, and so to work towards a definition of the area affected by tremors we must adopt some apparatus such as that described by Dr. Meinesz. That is one of the conditions under which work in part of India will have to be done.

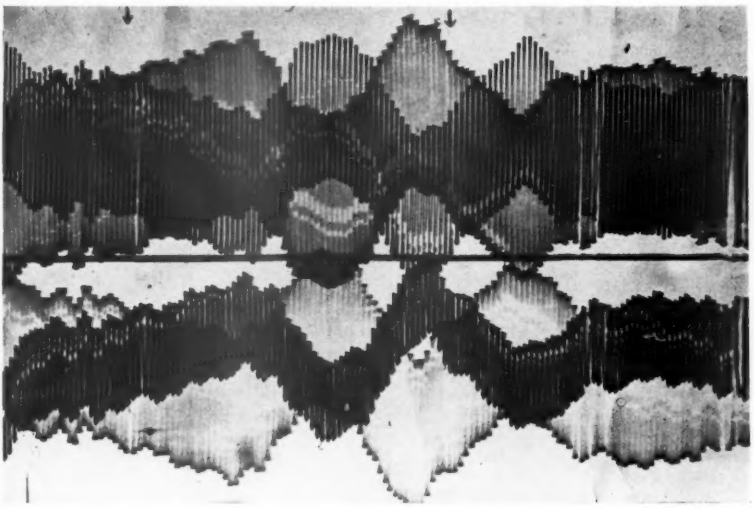
In another part, the determination of flexture correction will not offer the same difficulties, but the altitude of stations in the Himalayan region, for instance, makes the truth of the reduction of the time of oscillation to standard atmospheric pressure conditions a very vital matter. An air-tight chamber of some type in which the pendulums can be swung at controlled pressures will be most desirable. The design of an apparatus for India is, as you will understand, somewhat complicated. The conditions presented by the country are so varied, and then in the background there are the difficulties arising from poor and infrequent communications which set a limit to the bulk and weight of packages.

As for the pendulums themselves, I think there is no doubt they ought to be made of invar. The great advantage of using a material which has a very small expansion coefficient outweighs the disadvantage arising from the fact that invar has somewhat slight magnetic properties. The use of invar, I think, was originally suggested by Colonel Sir Gerald Lenox-Conyngham. This was opposed by Potsdam on the grounds of the magnetic properties of the invar. That led to the making of pendulums of fuzed quartz for the Survey of India at Lenox-Conyngham's instigation. The first of these, though treated with the greatest care, protected from shocks and jar, was found, after its journey to Bombay, to be broken. A second pendulum was made of a slightly different design which it was hoped would permit of the more ready distribution of residual molecular strain. That pendulum reached India about the beginning of the war. During the war pendulum observations were at a standstill, and for approximately ten years the pendulum was left to its own devices. During the summer of last year I had experiments started to determine the temperature and pressure constants of this quartz pendulum. It was first swung in Dehra Dun at the foot of the Himalayas, and was then taken to Missooree, about 4500 feet above Dehra Dun. It was there swung and brought back to Dehra. After the return journey, though the case con-



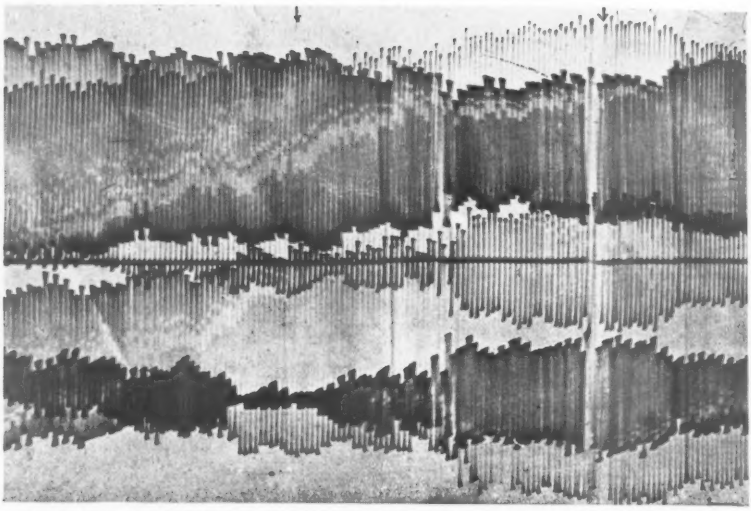
4. PART OF RECORD MADE IN HARBOUR AT TUNIS, SUBMARINE ON SURFACE, WATER VERY CALM

Amplitudes nearly uniform, implying small horizontal accelerations; and deviations very small, implying little angular movement of vessel.
The measures are made on the single interruptions, neglecting the double.



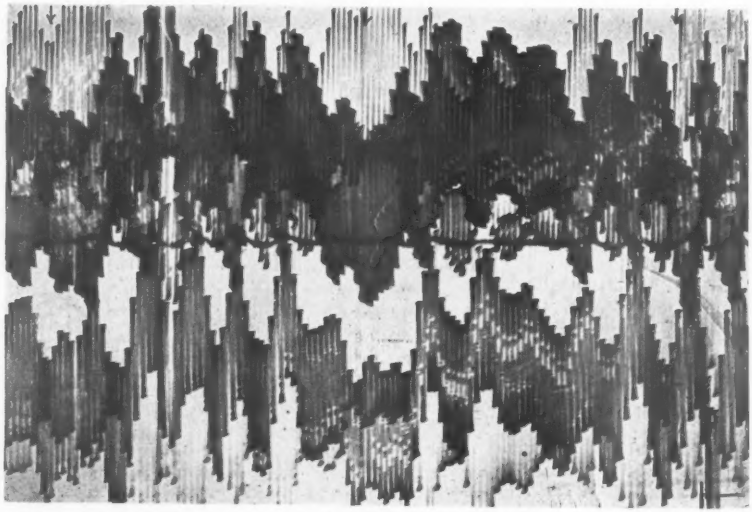
5. PART OF RECORD ON VERY CALM DAY IN MEDITERRANEAN, AT DEPTH 12 METRES

Amplitudes nearly uniform, but deviations considerable owing to movement of vessel.



6. PART OF RECORD IN HARBOUR AT SUEZ, SUBMARINE ON SURFACE

Amplitudes much disturbed, probably by bumping against sister ship. Deviations small, as vessel in still water. In spite of horizontal accelerations, mean error in period deduced for hypothetical pendulum only $4 \cdot 10^{-7}$ seconds, in series lasting 15 minutes.



7. PART OF RECORD IN INDIAN OCEAN, DURING LONG SWELL STILL FELT AT DEPTH 20 METRES

Amplitudes much disturbed and deviations large. Slight irregularity in angular velocity of resultant vector, due to vertical accelerations of vessel, much greater than usual.

taining the pendulum had been carried downhill by hand and had been most carefully treated and protected from shocks, on being unpacked this pendulum also was found to be broken. The only explanation that has been forthcoming so far is that of strain set up by want of molecular equilibrium. Fused quartz, apparently, does not seem a very suitable material of which to form pendulms. So far we have been most unsuccessful.

I may point out that we have completed what may be called the first series of pendulum observations in India. The present half-second pendulums went out to India about 1903 or 1904 after being standardized in Potsdam and swung at Kew, and were in constant use until the outbreak of war. Roughly some fourteen stations were visited during the ten years. Now the pendulums have come home, and they will be again swung at Kew, that is to say, re-standardized, and we shall then have a group of determinations in India sandwiched between two standardizations, one in 1903 to 1904, and the other this year. That will complete what I call the first series. They will then go out to India and commence a second.

Mr. C. S. WRIGHT: I would like to add my voice to the chorus of praise for the work of Dr. Meinesz. It needs a man of considerable vision and energy and faith to transfer a pendulum apparatus developed for use on land to a ship. Dr. Meinesz has discussed one or two points which specially interested me. Dealing with the inaccuracy of the pendulum observations on board ship, he has pointed out that uncertainty of temperature and timing are responsible for the greatest probable errors. Notwithstanding this, he gives the probable error of observation as 1 in 200,000. That is a very excellent figure in comparison with the calculated probable error for land observations. I wonder, however, if this calculated probable error of 1 in 200,000 can be relied upon any more than can the similar calculated figure for land observations? One can readily take land observations with a calculated probable error of (say) 1 in 500,000. Somebody else comes along, however, occupies the same station, and finds a value for gravity differing greatly from the one you have obtained—one quite outside the probable error that you have calculated or that he has calculated from his observations. Such differences are, I think, usually put down to changes in the set of the agates on the pendulum. I would very much like to have Dr. Meinesz's opinion on this point, because I think there is very little doubt as to the reality of inaccuracies in pendulum observations which lie outside the probable errors calculated from the observations one has made.

Arising out of the discussion there is one other point to which I would like to refer, namely, the use of quartz. Col. Cowie has told us his unfortunate experience with quartz, which I cannot help feeling is a matter of mischance. When one considers that wireless valves are made in quartz, it is a little difficult to believe that the cause of the trouble with his quartz pendulum was due to molecular strain. I cannot help feeling that if Col. Cowie could make another attempt it would be likely to be more successful, in view of the advance in technique since the last pendulum was made.

It is not long since I was reading a paper by Mr. F. E. Smith on measurements made some time ago at the National Physical Laboratory. The surprising statement was made in the paper that the greatest uncertainty in the observation for measurement of electrical current was due to uncertainty in the value of gravity. This, I have no doubt, will be rectified before long, but it does suggest that it might be worth considering whether a current-balance method might not be used for measuring gravity. I

think that is possibly worthy of Col. Sir Gerald Lenox-Conyngham's consideration.

Mr. H. L. P. JOLLY (Ordnance Survey): It is not often we have work done which possesses such interest both with regard to its results and with regard to the method employed. I think there was nothing about which geodesists wished more to know, or a field of work in which they were more anxious to have results than that of gravity at sea. And again, if anybody, before these experiments were conducted, had made the suggestion that it was possible to determine gravity at sea by the same methods as employed on land, with the necessary modifications, most people would have laughed. But Dr. Meinesz belongs to the group of men who look a difficulty in the face and eventually overcome it.

One point I noticed in Dr. Meinesz's lecture which seems to lead to a suggestion, and that is that the only disturbing influences which are difficult to overcome are the horizontal accelerations. Why not magnify the scale of the apparatus and attempt to install it on an ordinary steamer? If the scale is magnified sufficiently, then the horizontal accelerations will be no more disturbing on a large vessel than on a small one. The natural rolling of a large steamer is very much less rapid compared with the natural period of the apparatus; therefore it should be less harmful. An apparatus of this kind could be installed upon a steamer and left there for good. As long as an officer on the ship were instructed in its use, it could be made part of the ship's permanent apparatus, and I do not see that there is any reason why the same success should not attend the results.

In one or two of the slides Dr. Meinesz has exhibited I noticed that the amplitude of one pendulum was very much less than that of the other. I wonder whether he gets any results out of these particular records? because the effect of horizontal accelerations is obviously much worse when the pendulum has only a small acceleration at its maximum. You can imagine the ship giving a lurch just at the wrong moment, so that one pendulum is brought to rest absolutely. It might remain so for some minutes and then there might be a lurch in the opposite direction. I take it nothing very much would result from that, because you would realize that some swings had been omitted. But suppose the thing were altered abruptly in phase by 180°, then I see no reason why one half-swing of the pendulum should not be eliminated. I should imagine from initial considerations that for getting good results out of the apparatus, it is necessary to have the amplitudes nearly equal for the two pendulums, but I see that Dr. Meinesz shakes his head, and I am glad that my objection is not valid.

I should like to add a word of praise on the way in which Dr. Meinesz has given the lecture in a language other than his own, a thing which I think very few people have the same facility in doing.

Mr. A. R. HINKS: I should like, Sir, if you will permit me, to take advantage of the fact that the Hydrographer of the Navy is present to ask him a question with regard to the reception of time-signals upon submarines. I was interested to find in Dr. Meinesz's paper that one of the difficulties was that he did not get sufficient time-signals, and considering how many stations he might have been in touch with on that voyage to Colombo I was surprised. I suppose that there must be technical difficulties in receiving time-signals on submarines, and it seems to me it would be interesting to hear from the Hydrographer what they are. I do not know whether it is necessary to come to the surface to receive signals, or whether they can be obtained when the

submarine is submerged. As the question of time-signal reception is an important practical point, I think possibly Captain Douglas might give us a moment's help on the subject.

Captain H. P. DOUGLAS, C.M.G., R.N. (Hydrographer of the Navy): I think one of the great difficulties that Dr. Meinesz had was owing to the fact that, apparently, he had one or perhaps only two chronometers on board.

Dr. A. VENING MEINESZ: One.

Captain DOUGLAS: Of course it is rather hard to put any reliance on one chronometer. As regard our submarines, I do not think there is any doubt about their being able to get a time-signal anywhere. If you carry three chronometers, which you should do in a submarine, especially when going to China or the East Indies, I do not think there would be any difficulty in obtaining the time and keeping it accurately. The "A" chronometers which are supplied to our ships now have an error of perhaps 0·2 second a day, gaining or losing; that is an ordinary chronometer, and of course for a voyage such as Dr. Meinesz took the best chronometer would be chosen, and having three it would be possible to compare one against the other. There is no doubt that it ought to be possible, even in a submarine with a wireless mast to get time-signals twice or three times a day. The great advantage would be to obtain the time-signal from the same station. I understand from Dr. Meinesz that he started off by taking the Vernier time-signals from the Eiffel Tower, and then got them in the Mediterranean from Lyons. After that he lost them, and had to pick up another station which was simply the ordinary dot-and-dash signal, which is not, of course, what one would call an accurate way of obtaining time. By the other method it would be possible to get time within one-hundredth of a second. Unfortunately, out East I do not think there is a station which gives these Vernier signals.

Mr. HINKS: You might have heard Bordeaux?

Dr. MEINESZ: The wireless apparatus went to a wave-length of 16 kms., which was not sufficient for Bordeaux. I had anticipated before starting that I would be able to receive Lyons until Java was reached, and had not taken measures for being able to take Bordeaux over the whole voyage. That could easily have been done if I had taken another coil with me. In regard to future voyages I shall take special measures for being able to receive Bordeaux or other time-signals.

I may add that I had a very good chronometer. The rate of the chronometer rarely changed on board more than one-tenth of a second between consecutive days. I had no other chronometer at my disposal which came near to that, and so, as it would have been meaningless to take a second inferior one, I had no control chronometer with me. I am endeavouring now to get a second very good chronometer for controlling in order to be sure that there is not a large rate irregularity by chance in it.

Then there is another point. It might be a good arrangement to have time-signals with short intervals, so that it would be possible to take time-signals before going down and after the observations. That would be a great advantage. But for that purpose it would be necessary to have a very accurate recording apparatus, because to get the rate from two time-signals which are distant, perhaps, three hours with sufficient accuracy it would be necessary to have much greater accuracy than to a hundredth of a second in the receiving apparatus. Therefore it will be necessary to take recording instruments, and then comes in the difficulty that the aerial on a submarine is not very great, and when the submarine has been submerged and has come

up again it is wet, so that the energy from it is not so good. It will certainly be somewhat difficult to get a time-signal received and recorded when it is given a short time after the observations. I think, therefore, that it will be more practical to accept the other solution as given by Captain Douglas, and to take two or three chronometers as good as possible.

Captain DOUGLAS: Or better still, five.

Dr. MEINESZ: I quite agree. Then Colonel Cowie mentioned the possibility of making a new apparatus. I should like to suggest to him the possibility of adopting the idea of measuring at once the difference of elongation of two pendulums swinging in the same plane. They will be quite free of all horizontal movements—automatically free. Not only would it be possible to eliminate the movements, but you can get that without any computation.

Then quartz has been mentioned. There were some trials in Potsdam with quartz pendulums a long time since, and there was one question which was very disconcerting, namely, that quartz pendulums showed rather unexpected fluctuations in time of oscillation, and the reason given was—and I think there was some justification for it—that moisture was absorbed by the surface of the quartz. Perhaps there will not be any great difficulty now vitreous quartz is being used, for it may be expected that it will not absorb so much moisture, and will thus be much more satisfactory. Perhaps also it might be possible to metalize the surface. It is certainly a question which ought to be taken into consideration.

With regard to the points which Mr. Jolly raised. First, the question of horizontal accelerations. It is true that the disturbance of the time of swing of a pendulum with small amplitude is much bigger than with a great amplitude, but the disturbance of the pendulum vectors is the same, and so the difference of these vectors is undisturbed, independently of the magnitude of the amplitudes. However, the angular movement of the vector of the pendulum with small amplitude is much more disturbed than that of the pendulum with the big amplitude, and that causes the disturbance of its time of swing to be greater. It follows that it is not necessary for the elimination of the effect of the horizontal movements to have equal amplitudes and contrary phase as Mr. Jolly supposed, but it makes the computation much easier, because in that case it is not necessary to construct or compute the vectors. You can say, then, that the angular velocity of the vector of the hypothetical pendulum is the mean of that of the two original vectors, so that when you have two pendulums swinging in opposite phases with the same amplitude the mean of the pendulum oscillation is undisturbed. This simplification can however only be applied on land, as at sea these conditions would change too rapidly.

Then Mr. Jolly raised the question of the possibility of carrying out observations on board an ordinary ship. I do not think it will be quite impossible to do that, and when we make a bigger apparatus it will be easier to do it because then the disturbance is less, as Mr. Jolly said. But there are two questions: first, the vertical accelerations which cannot be eliminated; it is therefore necessary to pursue the observations so long and to take so many points at the beginning and at the end to ensure that the error is reduced to a value which is not too big. Now I fear that the vertical acceleration will be much greater generally on board an ordinary steamer. It is not only because it is on the surface of the sea, but besides that it will generally be impossible to get the apparatus near to the meta-centre of an ordinary vessel. If you get to the sides you get also the rolling effect in the vertical

acceleration ; whereas the submarine gives the secondary advantage that you can put the pendulum apparatus near the metacentre of the vessel, and thus rolling or pitching in itself does not give vertical movements. Again, the vibrations of the engines will be a difficulty an board an ordinary steamer. I have mentioned the fact that the knife-edges did not slip on the agate planes, but I should think the effect of the rocking of the agate planes coupled with vibrations would bring them down. When the submarine was submerged a certain velocity of the cooling machine gave some oscillation, and I was under the impression that the knife-edges were beginning to slip. Therefore I fear rather that bigger vibrations would cause them to slip. The submarine is moved by electromotors when it is submerged, with the result that there is very slight vibration, which is of great advantage in the use of the apparatus. Besides, we could choose the most favourable velocity, but in the case of an ordinary ship this will not be possible, so that difficulties may arise.

The PRESIDENT: You will certainly desire me, on your behalf, to convey to Dr. Meinesz your grateful thanks for having come over and given us this most interesting lecture. I hope that Dr. Meinesz will not imagine that the interest in the subject which he has placed before us this afternoon is to be measured by the size of the audience which has listened to his paper. Our afternoon audiences are always very small, but I hope I may say that they are very select. I suppose the reason is that the man who is not a specialist finds it difficult when listening to a lecture upon a very technical subject, to appreciate all the implications of what he is listening to. He requires to see it in print in order that he may have time thoroughly to take in what it is that is being placed before him. For that reason those who take an interest in our lectures are very much larger in number when those lectures appear printed in the pages of the *Journal* than they are actually in the lecture room at the time. I think I may confidently assure Dr. Meinesz that when his paper appears in our *Journal* it will attract the attention of a very large range of readers, and that it will become clear to the ordinary intelligent person, as it must be already to the specialist in this subject, that the work which Dr. Meinesz has been doing in recent times does indeed constitute a very appreciable advance in the science of determining the gravity of the Earth. I offer Dr. Meinesz once more the most cordial thanks of this audience.

THE INTERNATIONAL GEOGRAPHICAL CONGRESS AT CAIRO

THE Congress of the new International Geographical Union took place in Cairo from April 1 to 9 last. It was held in Cairo in deference to the request of the Société Royale de Géographie d'Egypte —late Société Khédiviale de Géographie—so as to coincide with the celebration of its fiftieth anniversary. For fifty years this Society has been in existence—it was founded by Ismail Pasha at the suggestion of Dr. Schweinfurth, in 1875—but until this year it had not been very prominent amongst the geographical societies of the world. King Fuad has however shown much energy and spent much money during the past year or two in its constitution; and it now boasts an excellent building,

including a large meeting-hall, decorated effectively in the neo-Arabesque style, and a number of rooms, devoted as a rule to agricultural and other exhibits and specimens of considerable economic value.

Fourteen nations were officially represented at the Congress, the chief absentees being the United States and the Scandinavian countries, which have not yet joined the International Geographical Union, and the late enemy countries—excluded by statute of the International Research Council. It was expected at first that arrangements should be made for 100, then for 200, members; but the numbers far exceeded the original estimate. According to the official, though admittedly inaccurate, list—which was only issued on April 8—there were about 590 members present, including 173 Egyptian, 91 French, 51 Italian, 63 Polish, and 32 British; but of the last there were not really more than 12 genuine representatives, besides 6 ladies of their families.

The British representatives were: Col. Sir Francis Younghusband and Col. H. G. Lyons, F.R.S. (official representatives of the British Government); Col. Sir Charles Close, F.R.S. (Secretary-General International Geographical Union); Major-General Lord Edward Gleichen (representing the Royal Geographical Society); Vice-Admiral Sir John Parry (President International Hydrographic Bureau); Lieut.-Col. C. B. Gunter (Survey of India); Lieut.-Col. J. E. Craster (Ordnance Survey); Professor H. J. Fleure (Secretary Geographical Association and University of Wales); Mr. W. W. Jervis (University of Bristol); Professor W. Roxby (University of Liverpool); Professor J. Joly (University of Dublin); Dr. Marion Newbigin (Editor *Scottish Geographical Magazine*).

Two or three days were spent, before the actual Congress, in Alexandria, where those members who were present were hospitably entertained by the municipality and shown the interesting historical and other sights in and around the town.

The President of the Congress, in succession to the late lamented Prince Roland Bonaparte, was the Italian General Vacchelli, who, assisted by the Secretary-General, Col. Sir Charles Close, carried out his duties to the eminent satisfaction of all present.

The chief brunt of the organization fell on the Secretary of the Royal Egyptian Geographical Society, Monsieur Adolphe Cattaui Bey, who worked most strenuously and successfully to make the Congress a success; while Adli Pasha Yeghen, ex-Prime Minister, and Monsieur Georges Foucart acted as Royal Egyptian Representative and President of the Society respectively.

After a couple of small preliminary meetings, devoted to the settlement of procedure, etc., the Congress was officially opened, in the Opera House, on the afternoon of April 1. King Fuad was present, and after a Presidential address by General Vacchelli and speeches of welcome by the Prime Minister, Sarwat Pasha, and Adli Pasha, His Majesty in a few words declared the Congress open; and Monsieur Pelliot, the French

representative, made an appropriate little speech in return. In the evening a number of representatives from each nation were invited to Abdin Palace and presented to the King. The representative of the (British) Royal Geographical Society then, by desire of the President and Council, respectfully invited His Majesty to become an Honorary Member of the Society—a distinction which the King most graciously accepted. A concert, ballet, and supper terminated the proceedings.

Another preliminary meeting was held on the following morning, for the selection of Vice-Presidents of the Union (Vice-Admiral Sir John Parry and, by selection by His Majesty, Hassanein Bey), and presidents of Sections, etc. Subjects were divided into the following Sections:

I. Mathematical Geography, Geodesy, and Cartography (Sir Francis Younghusband and Professor Arctowski (Poland)).

II. Physical Geography (M. de Margerie (France) and Professor Olinto Marinelli (Italy)).

III. Biological and Human Geography (Señor Jose Galbis y Rodriguez (Spain) and Professor Michon (France)).

IV. Anthropology and Ethnography (Abdel Rahim Bey (Egypt) and Professor Fleure (England)).

V. History of Geography and Historical Geography (Professor Almagià (Italy) and M. de la Roncière (France)).

In the afternoon members were conducted over the great Egyptian Museum, where some of the beautiful Tut-ankh-Amen treasures attracted great attention; and later another meeting was held, at which a few short lectures were given.

Work began in earnest on the morning of April 3, when numerous lectures were delivered; and in the afternoon congratulatory speeches were made on the occasion of the Jubilee, including the presentation of the Royal Geographical Society's address, on vellum, to the Royal Egyptian Geographical Society.

More lectures were delivered on the mornings of April 4 and 6, and on the afternoon of the latter day. Many of the lectures promised to be of considerable interest; and it is to be regretted that in the short time available for work, with so many lectures to be delivered, the lecturers were limited to half an hour at the outside—often only to a quarter of an hour or twenty minutes—for the exposition of their subjects. On the other hand, the Executive Committee and the leading inhabitants of Cairo surpassed themselves in the hospitalities lavished on members of the Congress. The King gave a great tea-party at the Pyramids; there was a whole Sunday devoted to an excursion to Saqqara and ancient Coptic churches, and another half-day to the Barrage; large parties were conducted over the chief mosques, the Arab Museum and Library, the Citadel and Heliopolis; and members were invited to the Arab Theatre, to an Arab concert, and to evening parties, dances, and suppers given by Adli Pasha and Monsieur and Madame Foucart. All members were

given a special bronze plaque and ribbon to wear as "insignes," and a select number were presented with large silver-gilt commemorative medals. In addition, the King presented the Order of the Nile to a number of the more prominent representatives; free passes to all places of historical or archæological interest were issued; and members were made free of all railways during their stay.

Further excursions, which were taken advantage of by parties of twenty to thirty members, were organized to Dakhla Oasis, to the Fayum, to Luxor and back, and even to Qena, Qoseir, Sinai, and the Red Sea. These took place after the Congress; but the prospective heat put many people off.

The Congress itself was wound up by a "Clôture Solennelle" on the afternoon of April 9, and the proceedings came to an end with a gigantic banquet at the Heliopolis Palace Hotel in the evening, at which many heartfelt speeches of gratitude were made.

It is impossible to give here a *résumé* of the lectures delivered, a large number of which referred to Egyptian and Near and Middle East subjects only; but of about 120 lectures delivered the following call especially for remark:

Recent Progress in the survey of Egyptian Deserts (J. Ball).
Sullo stato attuale degli accordi internazionali per la classificatione e la terminologia dei fondi sub-oceani (Conte G. Ricchieri).
Carte générale bathymétrique de l'Océan (2e Édition), de S. A. R. le Prince de Monaco (E. de Margerie).
Presentazione di una carta delle foci del Pò (1911–1924) del Istituto Geografico Militare (O. Marinelli).
New researches on climatic variations (M. Arctowski).
L'Hydrographie dans ses rapports avec la géographie (V.-Adm. Sir J. Parry).
Présentation d'un volume sur les lacs de Suisse (L. W. Collet).
Routes anciennes du désert (J. Barthoux).
L'organisatione della geografia nel Polonia (L. Sawicki).
Prehistoric trade and intercourse in Atlantic Europe (H. J. Fleure).
Les anciens rapports de l'Egypte et de l'extrême Orient (P. Pelliot).
Art and Geography (Sir F. E. Younghusband).
Mémoire sur la géographie de la Basse Egypte à l' époque Arabe (H. H. Prince Omar Toussoun). Many copies of the book (in 2 vols.) were distributed by H. H.
La carte de Christophe Colomb (Ch. de la Roncière).
The geography of the New World as interpreted by the early explorers and map-makers (illustrated) (Prof. Stevenson, U.S.A.).
Radio-activity and geography (J. Joly: unfortunately not delivered owing to the illness of the author).
Sur l'application de la cinématographie dans la géographie (Vittoriano Ascarza).
Hassanein Bey again delivered a lecture on his desert travels.

It is intended to publish 2 volumes (in French and Arabic) on the work of the Congress, including all the lectures; but it is not likely that they will appear before 1927.

Among other resolutions passed, the following is worthy of attention:

"The International Geographical Congress assembled at Cairo expresses the sincere hope that the different questions relating to the World Map on the scale 1/Million which have been submitted by the Central Bureau (of this International Map) should be thoroughly discussed by this Bureau, during the course of the next two or three years, with the interested States, in view of the definite decisions to be taken thereon by the International Geographical Congress to be held in England in 1928."

Measures were also taken for the discussion and settlement of definite international names for a number of bays, gulfs, and seas, etc., whose names are now differently given by different nations. The centre of this discussion will be the International Hydrographic Bureau at Monaco.

It may, finally, be mentioned that the languages officially permissible at the Congress were English, French, and Italian. Most of the lectures were delivered in French. E. G.

THE RIDDLE OF THE PACIFIC

The Riddle of the Pacific.— J. Macmillan Brown. London: T. Fisher Unwin. 1924. 10½ × 6¼, pp. xii. + 312. *Sketch-map and Illustrations.* 30*s. net.*

IT is not easy for one who has never been on the spot to review a book such as that which Mr. Macmillan Brown has produced. It aims at dealing more or less intensively with the problems which arise from the unique and very peculiar features exhibited by the ancient cultural remains of Easter Island, a derelict spot in a vast ocean, which has probably afforded more knotty problems wherewith to puzzle and intrigue ethnologists and archæologists than any other area of equally insignificant size. Easter Island, in fact, bristles with conundrums.

The author of this new work has entered upon his task whole-heartedly and with much confidence; and, apparently, wrote the book in the most suitable of inspirational environments—the island itself. The theory upon which he bases his attempted solution of the problems is attractive and plausible, inasmuch as, if it could be proved, it would certainly offer a reasonable explanation of the strange phenomena which give to Easter Island its distinctive character. In the main, this theory involves the assumption that the island itself is the remnant of a once extensive archipelago which formerly encircled it and included islands of considerable size, well timbered, and capable of supporting a very extensive population, under the organization and control of powerful chiefs. Further, it is suggested that Easter Island was the great mausoleum of this highly developed community, to which tens of thousands of skilled and unskilled labourers were drafted to carry on the vast work of building the *ahus*, or burial platforms, out of carefully dressed stones of huge size and of extremely hard material; and also of sculpturing *in situ* and transporting from the crater of Rano Raraku the huge monolithic statues which served as memorial effigies. The vastness of this cyclopean work is unquestionable, and the need of a great industrial population to carry it out must be assumed; and, since the very barren island appears never to have been capable of supporting such a population, the main food supplies must necessarily have been derived from elsewhere, together with sizeable timber and the material for making cordage, etc. These are admitted facts, and the problem of accounting for

the evidence of a vast cemeterial industry having once flourished in what is now a completely isolated, sparsely vegetated volcanic islet, would be materially simplified and to all intents and purposes solved if it could be proved that the island was once girdled by a chain of extensive land areas.

Apart from the demand for some such assumption, which arises from an attempt to account for the striking megalithic industry of the island, Mr. Macmillan Brown relies upon the actual former existence of "Davis Land," an extensive area of high lands reported by the buccaneer Edward Davis, captain of the *Batchelor's Delight*, in 1687. Davis's account has been the subject of much debate, and its trustworthiness has been generally discredited. In the absence of his log (if he kept one) it is difficult to evaluate his statement. The matter was carefully and impartially considered by the late Dr. B. Glanvill Corney (*Geogr. Journ.*, July 1917), who suggested that probably the "small flat Island" and the "range of high land" about 12 leagues further westward, reported by Davis, were Temoe Island (Crescent I.) and the Gambier Group (Manga Reva) respectively, and that the navigator was considerably out in his calculation of position. Mr. Macmillan Brown does not appear to be aware of Dr. Corney's reasoned criticism, unless, in the absence of reference, we are to conclude that it is the latter's suggested identification of Davis Land with Manga Reva which the author describes as "the midsummer madness of criticism and theory" (p. 43). Why this unnecessary outburst? Dr. Corney's diagnosis of the statement, no doubt, does not fit Mr. Brown's theory, but it does fit the facts as at present known.

The author's theory of a submerged archipelago is called into being to support his diagnosis of the culture-phenomena, but it finds little support from tangible facts, and remains, in the absence of substantial data, a nebulous, if plausible, assumption. The insignificant, uninhabited islet Sala-y-Gomez, some 300 miles east of Easter Island, alone remains to suggest the former archipelago to the east; while to the westward there is practically nothing for hundreds of miles. The soundings, as at present known, do not seem to bear out the theory of a recently foundered archipelago in this part of the Pacific. If it ever existed in the position suggested, the subsidence of this extensive area of high lands must have been phenomenally rapid and complete, since it had vanished entirely (except for Sala-y-Gomez) in the space of thirty-five years, and was nowhere to be seen when Roggeveen arrived upon the scene in 1722; great depths, moreover, are recorded as prevailing in this region. It is to be hoped that a detailed survey of this part of the Pacific may some day be made, as comprehensive bathymetric data are badly needed and would serve as a real test of the theory of a vast and rapid subsidence in recent times.

The book appears to be intended for the general reader rather than for the scientist, and references to the sources of information forming the basis of statements are very rarely given, a very serious detriment to a book of this kind. One may gather that many of the details were supplied by Juan Tepano, a native who acted as the author's guide and who had inherited traditions and folk-lore from his mother. But the memory of the bygone culture is extremely nebulous, and many of the legends are so obviously fanciful and untrustworthy, that too much reliance should not be given to this class of data. In spite of meagre material, Mr. Macmillan Brown has contrived to build up a picture which to a great extent hangs together and is plausible, if by no means entirely convincing. It is a pity that he has so largely overlooked or ignored the views expressed by other recent writers, since this omission weakens the authoritative status of his own work.

In dealing with the ethnological problem of the "Long-eared" and "Short-eared" elements in the population, the author derives the former from the Marquesan Group and the latter from New Zealand. He has little to say for the Melanesian influence which has recently been strongly advocated both on physical and cultural evidence. Craniological investigations have made evident a pronounced Melanesian element in the mixed ancient population of Easter Island; and several features in the material and æsthetic arts point strongly to a similar derivation. The elaborate cult of the Frigate-bird is more readily derivable from Melanesia, the great home of this cult, than from Polynesia, and the representations of the Frigate-bird, both in the realistic and semi-anthropomorphic renderings, find striking parallels in the Solomon Islands, and not in Polynesia. Mr. Brown's diagnosis of the figures of the Frigate-bird, emblems of the god Makemake, is hard to follow. Conventional as the figures mostly are, it seems unnecessary to assume that the forked tail must be that of a fish grafted upon the bird design, when a conspicuously forked tail is one of the prominent natural attributes of this bird. The author suggests that the tail is, more specifically, that of a shark, but there is no suggestion in the figures of the characteristically unequal lobes of a shark's tail. But zoology is not, perhaps, the author's strong suit, since he speaks (p. 211) of the "sawlike snout of the swordfish," an obvious confusion of two widely separated types. In his anxiety to prove that the Easter Island culture was almost exclusively Polynesian in origin, his argument at times becomes laboured and unconvincing. In referring to the huge cylindrical blocks of red tufa which crowned the heads of many of the statues, Mr. Brown favours the suggestion that they "had their original model in the hat of some visiting or shipwrecked sailor"; but this view can hardly be taken seriously, since, even if a resemblance to the suggested prototype can be discerned, the red tufa crowns were already "ancient history" in the days of the early European voyagers who reached the island.

There are various inconsistencies in the author's statements. For instance, on p. 24, "The biggest canoe it could produce was . . . incapable of carrying sail . . . and bailing was the never-ceasing necessity of sailing." Again, on p. 69, "it is well known that no canoe large enough to carry sail was ever made or used on the island," a statement which is followed in the next paragraph by another to the effect that it was the forests of the surrounding archipelago which "supplied Easter Island with the . . . long thick timbers needed for building oceanic canoes"! Grammatical slips are not infrequent. "There is no other sea-bird had the combination" (p. 103), and "There is no such landless area on the face of the earth than this same south-eastern region of the Pacific Ocean" (p. 50), are jarring examples.

If one is forced to adopt a critical and somewhat sceptical attitude in attempting to review this book, it is because the volume is beset with controversial points which challenge criticism. To the general reader the book should prove attractive. The subject is a fascinating one, the writer's enthusiasm is infectious, the volume is well printed and well illustrated. The author, moreover, makes many excellent and telling points. But it is the work of an enthusiast rather than a scientist. The bias of a particular theory dominates and pervades the whole, and seems to blind the author to discrepant factors which, however, must be taken into account before any final solution of the problem can be arrived at. Mr. Macmillan Brown has shown skill in developing his argument and in presenting a picture of the life-story of the people, and he offers some valuable suggestions which are worthy

of serious consideration. If his contribution to this difficult and fascinating topic appears to be one-sided, this in itself may prove advantageous, since it will help to keep alive the discussion of a problem which still awaits solution. The "Riddle of the Pacific" is not yet convincingly answered.

HENRY BALFOUR.

RADIOACTIVITY AND EARTH HISTORY

J. Joly: (*a*) "The Movements of the Earth's Surface Crust," *Phil. Mag.*, Ser. 6, vol. 45, No. 270, June 1923; and No. 271, July 1923.

(*b*) **Radioactivity and the Surface History of the Earth.** (The Halley Lecture, 24 May 1924.) Oxford University Press. 1924. Pp. 40, with an Orobathygraphical Chart of the World, showing Tertiary and Recent Volcanic Areas. 4*s. net.*

TWO years ago Prof. Joly published a distinctly revolutionary paper dealing in an entirely original manner with radioactivity as the dominating influence in controlling Earth-movements. The Halley Lecture of last year afforded him a suitable opportunity of presenting his views afresh, but though the method of treatment is perhaps more attractive, the matter is practically identical with that of the earlier and more technical statement. We may therefore conclude that, despite the appearance of a certain amount of adverse criticism, the author has found no adequate reasons for modifying his ingenious and far-reaching ideas.

It is well known that the rocks of the Earth's crust all contain minute quantities of the radioactive elements, thorium and uranium, which, together with their daughter elements, are constantly generating heat at a rate which is quite unaffected by any pressures or temperatures that are likely to develop in the outer parts of the Earth. The present Lord Rayleigh was the first to point out that these remarkable facts made it necessary to abandon Kelvin's classical theory of the cooling of the Earth, and he further showed that unless the Earth's whole store of the radioactive elements is concentrated in the outer crust, leaving the interior free from their embarrassing evolution of energy, the Earth must inevitably be growing hotter. There is now no doubt that the distribution of the radioactive elements does in fact fall away in depth, for granites are three times as rich as basalts, while the latter are twice as rich as the still denser and more basic peridotites. In dealing with possible geological consequences of the generation of radiothermal energy it has generally been assumed that the falling off in depth was sufficiently rapid to permit the Earth to have cooled down during geological time, though necessarily much more slowly than was formerly contemplated. Naturally it seemed impossible to believe that the Earth could have behaved otherwise, if it began its existence as a molten globe. Nevertheless it has been felt that the assumption placed a somewhat irksome and artificial restriction on the Earth, and it must be freely confessed that the deductions drawn from it have failed to match the known facts of geological history in several important particulars. It is, for example, particularly difficult to explain the existence of tension in the crust, and impossible to devise a convincing process whereby vulcanism can break out on a large scale away from geosynclines and folded mountains, as it did in the Brito-Arctic and Deccan provinces in early Tertiary times. Such phenomena as these make it imperative to allow in the

depths a greater proportion of the radioactive elements than a steadily cooling Earth could possibly have contained.

The way of escape from an apparent deadlock has been discovered by Prof. Joly. It lies in the alternate accumulation and dissipation of the latent heat of fusion of basaltic material. The ebb and flow of heat acts as a governor or regulator of temperature of a most efficient kind, as we shall now see.

In the new theory it is assumed that the continents are essentially of granitic composition; that they are submerged in a substratum of basaltic composition which rises around them to form the ocean floors; that isostatic equilibrium is constantly maintained; and that the deep-seated basaltic material contains on an average the same proportion of the radioactive elements as the actual basalts that have flooded the lands and built up the true oceanic islands. From the evidence of seismic waves the thickness of the continents is assumed to be from 30 to 35 kms. The average specific gravity of the continental rocks is taken as 2·65, and that of the material of the basaltic layer as 3·00. These estimates, allowing for the water of the oceans, give a continental emergence above the ocean floor averaging 5 kms., and a submergence below its level averaging 27 kms. It is further assumed that on fusion the basaltic material increases in volume by ten per cent., and that at the temperature of fusion granite and gneiss remain unfused and continue to float.

It is thoroughly established that at the present day, apart from local residual pockets of magma, the substratum is effectively solid, even though it must be highly heated beneath the continents. With the figures adopted, and taking the known distribution of the radioactive elements of the continental rocks to be uniform throughout their thickness, the temperature at the base of the continents works out at approximately that of the fusion-point of basalt, while the heat produced within them is approximately equal to the amount lost from the surface by conduction and radiation into space. But the basaltic material below is also self-heating in virtue of its radioactivity, and since it lacks only latent heat to become fluid, it is easy to calculate that in about thirty million years it must become so throughout. Similarly at a certain depth beneath the ocean floor the substratum must also break down into the fluid state. By the slowly progressing increase of volume attending such changes the overlying crust becomes heaved up, and is consequently thrown into a widespread state of tension. Continents and ocean floor are rent asunder, and basaltic lava squeezes through the cracks. Tidal action starts a slow westerly drift of the still solid crust, and the deeper, possibly superheated magma, formed originally beneath a continental blanket, thus comes to underlie the ocean floor to the east. Gradually the ocean floor is stoped and melted away from below until the increasingly rapid loss of heat into the ocean overtakes the process and brings it to an end. As a result of convection and the sinking of solid blocks and of newly formed crystals, reconsolidation then begins, mainly from below upwards, until the continents in their westerly drift are grounded on a solid foundation, and the lateral movement is brought to an end. Each level of the substratum is then necessarily left at the temperature corresponding to its solidification-point at the pressure there existing, and the cycle whereby the excess of internal heat is accumulated and lost is completed.

The tectonic events brought about by the changing state and volume of the substratum are easy to visualize. As fusion becomes general the conti-

nents sink a little, and transgressional seas flow over the lower levels of the lands. Vulcanism contemporaneous with sedimentation is facilitated by the cracking of the crust under tension. When the magmatic expansion is at its maximum the area of the Earth's surface is greatly increased. Fusion through a thickness of 70 miles, for example, would increase the outer area by 650,000 square miles. As consolidation proceeds, the greatly increased area has to settle down on the contracting substratum, and the margins of the continents become the scene of intense compressions and deformations. It is to be noted that folding and overthrusting of the ocean floor cannot lead to conspicuous surface features on account of the constant intervention of isostatic readjustment. On the contrary, geosynclines filled with light sediments are squeezed both upwards and downwards, forming mountains that stand high above the general level of the continents in virtue of their compensating roots. Finally, isostatic readjustment completes the orogenic processes by raising the continents and the border ranges relatively to the now greatly thickened ocean floor and causing the seas to retreat once again from the lands.

In brief outline such is the ideal cycle of events conceived by Prof. Joly. Compared with the broad facts of the last great terrestrial revolution, the actual sequence of changes matches the deductions very convincingly. In the Eocene we find clear evidence of sinking lands and spreading seas. The ancient Tethys, the gathering ground of the Eurasian ranges of to-day, extends widely to the Pacific. Tension and magmatic pressure are demonstrated by the outflow of plateau-basalts of the Brito-Arctic, Deccan, and Oregonian provinces, and early in the Oligocene Africa is split along the lines of the rift valleys. Early in the Miocene the tectonic conditions begin to be reversed, indicating the passing of the climax. The Alps are folded and overthrust, and begin to rise with the emerging continents. In Middle Miocene times the incipient Himalayas are more strongly folded and upraised, and the eastern extension of the Tethys disappears. In the Pliocene the consolidation processes approach completion. The Caucasus is developed, and further upheaval of the Alps and Himalayas takes place as the Tethys approximates to the Mediterranean as we know it to-day. The Pacific region is now near the concluding phases of the great revolution, for there is current evidence of downward movement of its floor and of uplift along its shores.

In detail, and especially as the events of earlier revolutions are reviewed, it would appear that the processes have been much more complex than a simple repetition of the cycle can explain. Much has been written in the past about the alleged periodicity of Earth-movements and igneous activity, but accumulating evidence shows that while periodicity of a broadly regional character can be recognised, it is by no means world-wide. In general, however, it is not to be expected that the latent heat cycle will everywhere run its course either at or during the same time, and world-wide periodicity should therefore be rare. Prof. Joly recognizes that his theory allows for very considerable variations in intensity according to the depth of the substratum affected in any given period. It is probable that ultra-basic material relatively poor in radioactive elements extends beneath the basaltic layer to a depth of hundreds of kilometres. Considerably longer intervals of thermal accumulation are there required for widespread fusion than in the shallower levels of the lithosphere. Each zone or localised area of fusion produces its own effects, and there must constantly be a certain amount of interference, giving at long intervals additive diastrophic effects of the first magnitude.

These alone should be of world-wide occurrence, and they may become ultimately detectable when sufficiently detailed tectonic evidence has been gathered from all parts of the world.

Since the impressive and possibly world-wide revolutions of the Archæan, Prof. Joly tentatively acknowledges five major periods of mountain-building, and suggests that each cycle required from 40 to 50 million years. His estimates are based as before on the assumption that the radioactive elements in the depths are as abundant as in the surface rocks of corresponding composition to which we have access. It is very doubtful whether this assumption could be sustained in view of the fact that every cycle implies a long period of magmatic differentiation which would probably promote a marked outward concentration of the radioactive elements. In the opinion of the reviewer, most of the magmas that have approached or reached the surface are in this sense exceptionally radioactive, and it seems therefore to be possible to accept Prof. Joly's main conclusions on a much longer time basis than he himself is prepared to admit.

In other directions besides those of the distribution of radioactivity and the length of geological time, the subject bristles with controversial points which no doubt will be discussed for many years to come. Many of the problems involved will have to be tackled mathematically on lines such as those developed already by Dr. Harold Jeffreys in his recent book 'The Earth.' The main process, in so far as it is not a continuous one, is unfortunately likely to place particularly difficult obstacles in the way of mathematical treatment. The facts of geological history must, however, remain always the final court of appeal.

Of many burning questions only one more need be raised here, that of the origin of geosynclines. Prof. Joly suggests that during cooling and compression the borderlands of the continents become greatly thickened. Later, as fusion recommences, the borderlands descend relatively to the oceans and carry with them the adjacent continental plains, thus producing an elongated depression parallel to the coast, and deepest on the side of the borderland. This mechanism seems to be at variance with the demands of isostasy, particularly as recent evidence consistently supports the view that comparatively small areas may be in independent equilibrium. There seems indeed to be no escape from the deduction that the depression of a geosyncline relative to the adjoining land implies an increase of specific gravity in the underlying column. Appeal has been made to the possibility of the formation of minerals of lowered specific volume in the deeper layers of the column, but an alternative process involving a redistribution instead of a reconstruction of material seems not to have been previously suggested. The tendency of mountains or borderlands to drag down the adjoining regions as they sink into the growing and expanding magma favours the development of cracks which must ultimately separate the two crustal elements, since powerful tensional stresses are already being generated in the crust. The adjacent blocks will tend to move apart, and the lateral faces originally in contact will bulge slightly as separation progresses in response to the unbalancing of the lateral stress differences. Wedges of the upper crust will consequently slump downwards (as in a rift valley), and heavy magma will flow in from below. The gradually widening and sinking column of the crust thus developed seems to meet the peculiar functions required of a geosyncline. Moreover, when cooling, contraction, and mountain-building supervene, and the old foreland is pressed against the newly rising mountains, it may carry with it a load of

heavier basic rock that has become attached to the irregular undersurface of its wedge-shaped (in profile) lateral borders. From the start, therefore, mountains may be fringed with geosynclines, as in the puzzling case of the Himalayas and the Indo-Gangetic trough.

It will be clear from what has been already said that if the processes described by Prof. Joly be accepted in principle it is no longer possible to resist Wegener's intriguing displacement theory on the grounds that the continental blocks are at the present day embedded in a rigid substratum. Beside this apparently all-sufficient line of attack other adverse criticism has been a matter of comparatively unessential detail. But the insuperable mechanical difficulties that seemed to stand in the way of the alleged continental drift are now seen to be temporary and intermittent. Prof. Joly points out in his first paper that during the climax of a period of fusion almost anything may have happened so far as the stability of the ocean floor is implicated. It seems inevitable that under the influence of magmatic currents the ocean floor would be not only fractured but also engulfed to such an extent that it would no longer be able to present a continuous resistance to bodily movement of the continental blocks. The probability of at least occasional periods of drifting is therefore intimately involved in Prof. Joly's views.

By no means all the possibilities have as yet been fully explored. In addition to the minute but not negligible forces tending to move continental blocks from the poles towards the equator and from east to west, there are others of still greater importance due to the tendency of the land masses to distribute themselves uniformly, and to the changing form of the geoid brought about by tidal friction and the slowing down of the Earth's rate of rotation. The expansion and contraction of the outer part of the Earth corresponding to the fusion and consolidation of the basaltic layer, and the associated isostatic adjustments, must also profoundly modify the details of terrestrial dynamics. It is not to be expected that the complicated interplay of all these processes should always promote movements or establish redistributions symmetrical about the Earth's axis. Even a heavy snowfall or a migration of swallows must slightly affect the Earth's moment and axis of inertia. For this general reason considerable wandering of the poles relative to the present surface of the Earth is likely to have occurred in former ages.

In conclusion, then, we may hail Prof. Joly's inspiration as a contribution to geology of the first rank. The particular data adopted to give precision to its first exposition may not win complete acceptance, but the general principle should rapidly do so and lead to a fruitful and co-ordinating revision of many hypotheses. Through the dark cloud under which theoretical geology has lately been groping a new light is breaking, and the next few years should witness a gradual clearing up of the present muddle of contradiction, controversy, and unsolved problems.

ARTHUR HOLMES.

REVIEWS

Europe. Vol. I.— Edited by **B. C. Wallis, B.Sc.** Stanford's Compendium of Geography (New Issue). London: Edward Stanford, Ltd. 1924. Pp. xxiv. + 763. *With* 43 *Maps and* 120 *Illustrations.* 15*s. net.*

WHEN Mr. Chisholm published his first volume of 'Europe' some twenty-five years ago, it was the best book of the year; and, though it has never won the place occupied by his 'Commercial Geography,' many critics thought it then one of the best bits of work that he had ever done or would probably ever do. With this opinion the present reviewer is in complete agreement, and he is himself conscious of a very large debt to the volume.

To edit and revise such a volume is far from an enviable task, but Mr. Wallis has done it extremely well from all points of view. With the strictest and wisest self-restraint, he has left untouched every page which did not obviously demand revision; and where this has been necessary, he has pieced and patched the old in such a way as to delight the publisher by a minimum of resetting and to puzzle the reader as to which is the old and which the new. The only irrational thing—from the publisher's point of view—is the changing of illustrations from a right-hand page to a left-hand, this involving alteration of headlines—an unnecessary expense.

Many of the corrections are quite tiny, though valuable, *e.g.* the correction of the depth of the Dead Sea (p. 5) or the height of the Altare Pass (p. 57). Others introduce new material, based upon the researches of the past generation, *e.g.* on tides in the North Sea (p. 15) and on climate, where, however, Mr. Wallis allows himself to indulge in some straw-splitting. But it is cheering to see him—in spite of some strong expressions of what one might call one-eyed criticism in recent times—boldly using "abnormal," in reference to temperature, in its obvious and reasonable sense.

Some changes in the order of chapters have been made, nearly always for the better, especially the replacement of the Balkan by the Iberian peninsula as the link between Italy and France; and naturally Mr. Wallis has added some paragraphs on his own particular lines, *e.g.* about products.

In the entirely new pages there is some good work, *e.g.* on the structure of the Meseta and the relation of the Portuguese frontier to the scarp as a climatic divide; and the chapter on Poland is good. But on the whole the new countries have not been treated very happily, especially those in the Danube basin, where Mr. Wallis has not been able to shake himself free from Mr. Chisholm's treatment of the old Austro-Hungarian empire. And in one sense this is a tribute to the unselfish modesty with which Mr. Wallis has done his work.

L. W. L.

Ethnographie von Makedonien: Geschichtlich-rationaler, sprachlich-statistischer Teil.— Prof. Dr. Gustav Weigand. Leipzig: Friedrich Brandstetter. 1924. 9 × 6, pp. 104. *M.*3.

In his preface Prof. Weigand tells us that on 7 May 1917 he had a letter from Geheimrat Penck to say that it was proposed to utilize the occupation of Macedonia by German troops to collect as much material as possible about the country. The Kaiser had interested himself in the subject and given 50,000 marks to further the investigation. Prof. Weigand was appointed a member of the resulting Macedonian Land Commission, on account of his previous knowledge of Balkan ethnography. He took up his quarters at Nish, but did not require, he tells us, to undertake any additional journeys, as he had on hand a large amount of material, not all of which had been previously published,

as a result of his earlier journeys. The Commission had the assistance of six Bulgarians and about thirty Germans, and collected a large amount of material. Some of this is to be published later by Prof. Thilenius of the Museum für Völkerkunde at Hamburg. When Prof. Weigand finished his own part of the work in 1919 he found that the remainder of the Kaiser's gift had disappeared in the revolution, and the delayed publication and the absence of a map are results of the difficulties of independent publication. All the statistical material of the book refers to pre-war conditions.

As to his own qualifications, Prof. Weigand says: "I do not believe that any other traveller (auch nur ein einziger Reisender) has such an intimate knowledge of the nationality and the languages of the Balkan peoples as I have been favoured with, for the nature of my studies, the investigation of language and of folk-lore, has made it necessary for me to come into the closest contact with the people."

His general conclusions are, first, that the chief nationalities of Macedonia, in order of importance, are Bulgars, Albanians, Greeks, Aromunes, Spanish Jews. "The others, including the Serbs, have so few representatives that they need not be considered." In consequence he holds that the present political division is not only unjust and inhuman to the suppressed nationalities, but is also politically foolish; for "justice and freedom are the necessary conditions upon which alone world peace, for which all men yearn, can be attained." "Mankind must come to self-determination and must give up imperialism, which is the root of militarism." To reach this end he considers that an autonomous Macedonia should be set up to extend between the Bistriza and the Drin in the west and the Mesta in the east, stretching north to the Shar Mountains and the Kara Dagh. He fears, however, that it may be some time before justice and the voice of reason prevail. There is no general discussion of the difficulties of his suggested solution, nor of the economic questions involved. M. I. N.

ASIA

Crop-production in India.— **Albert Howard, C.I.E.** Oxford: University Press. $8\frac{1}{2} \times 5\frac{1}{2}$, pp. 200. 12*s.* 6*d. net.*

This is nominally a bit of propaganda, the natural sequel to Lord Curzon's important innovations and experiments twenty years ago; but if all propagandists were as scientific and as enthusiastic as Mr. Howard, the word would begin to have quite a new significance.

As one would expect from the agricultural adviser to the States of Central India—whose work as economic botanist in the Agricultural Research Institute at Pusa is not known nearly so well as it ought to be—the book is quite admirable. It stresses essentials in the simplest and clearest way possible, and is saturated with scientific zeal and precision. In fact, if it had no other value, the book would still be of immense political importance as an unconscious testimony to the extent and excellence of the work done for India at Pusa.

The book is exactly what its sub-title professes—"A Critical Survey," running quickly and concisely over the whole field, but always with the critical instinct wide awake. Part I. deals with the Soil, and is specially good in relation to the nitrogen and the alkali problems in the latter, of course essentially a modern problem, due to the haste of modern irrigators and their neglect of the experience accumulated by the natives during centuries of irrigation practice which resulted in no excessive development! (This

book may be specially recommended to some of the hustling irrigators in California.)

Part II. deals with the Crop, first generally, and then in details; and the selection and treatment of the essential for the various crops may be fairly called a model of what should be done. Special attention is given to cotton, wheat, rice, and sugar-cane; and in each case there is emphasis on just the three or four factors which are absolutely vital to the particular crop. Thus, in the chapter on cotton—a "dry" crop—the emphasis is laid on the need for a permeable and well-aërated soil; in that on wheat—a "cold season" crop—temperature is stressed, limitation of temperature at both ends of the season practically restricting the varieties and the geographical distribution. So the nitrogen problem is dealt with under "rice," the relation of temperature to moisture under "sugar-cane."

Part III. is devoted to Organization, with special reference to the ideal investigator—such as Mr. Howard is himself.

The book may be most strongly recommended to geographers.

L. W. L.

Peacocks and Pagodas.— **Paul Edmonds.** London: George Routledge & Sons, Ltd. 1924. 9 × 6, pp. xii. + 282. 45 *Illustrations by the author.* *12s. 6d. net.*

Mr. Paul Edmonds frankly admits that he visited Burma as a "fine-weather tourist"—the half-contemptuous appellation given by British residents to the casual winter visitor—and this book is a light-hearted account of his journey up the Irrawady as far as Bhamo. He did not stray far from the beaten track, but he has a quick eye for the unusual and the picturesque, and presents the fruits of his observations and experiences in a pleasant manner; he is always readable and often humorous, and some of his sketches of this sunny land and its people—perhaps the happiest and most contented in the world—are very effective. He has something to say on such varied subjects as lacquer-work, Burmese superstitions, ruby mines, opium smuggling, snakes, and leper asylums; all this, and much more besides, the general reader will find of interest, but to the student of Burma the most valuable of the author's notes will be those on Burmese music, the foundation of which, he suggests, is that earliest and most primitive of scales, the pentatonic. The chapter on politics gives a concise and lucid account of the situation in Burma to-day. Here Mr. Edmonds shows himself a sensible and well-informed observer, and recognizes that while the extremists of the towns (with the support of the priests) clamour for independence, the happy-go-lucky Burman of the country districts is indifferent to such aspirations and is unlikely to become restive so long as he has a rice-field to plant, a cheroot to smoke, and a quid of betel-nut to chew. Moreover, while he avoids the dangers of hasty generalizations, he maintains (rightly, as all who know Burma must feel) that whatever advantages the Burman may gain from any further political concessions, he will not add thereby one iota to his happiness.

O. R.

Early Travellers in Central Asia, 1603-1721.— **C. Wessels, S.J.** The Hague: Martinus Nijhoff. 1924. 10 × 7, pp. xvi. + 344. *Frontispiece and Map.* *21s. net.* *12 guilders.*

Recent explorers in Central Asia have had to face not only the natural difficulties of travel in that remote region, but also the jealousy and suspicion of the inhabitants. This aversion is of comparatively recent growth, and did not exist until Chinese rule influenced Tibet by "grafting its own love

of seclusion on the inhabitants." Therefore during the seventeenth and eighteenth centuries travellers were not confronted with this additional difficulty, and a considerable number of Europeans, particularly missionaries, were able to visit and partially explore the country. These travels were long neglected in general histories of Asiatic exploration, and though attention has been called to them in recent years the published accounts are often very summary and sometimes quite inaccurate. Father Wessels, who has for some time been known as a keen student of the subject, has produced a work which fills this notable gap in the history of exploration so far as concerns the travels of the Jesuits in Central Asia from 1603 to 1721 (for it must be remembered that something was done also by their successors the Capuchins).

The first two narratives—of the journeys of Bento de Goes and Antonio de Andrade—have the special interest attaching to pioneer work. Goes' achievement has been known to English students through Yule's carefully edited version included in his 'Cathay,' but Father Wessels is able to further elucidate certain points by the help of recent research. He discusses the question of the true name of the traveller, some having held that "Goes" was assumed only on his joining the Jesuits after a somewhat wild youth. But as it has been found that a family of that name was in existence at the traveller's birthplace—Villa Franca in San Miguel (Azores)—the author thinks the theory that the true name was Gonçalves (a family also represented there) must be abandoned. As is known, Goes' journey was undertaken with a view to determining the identity of the Cathay of the mediæval travellers, the result being to prove the correctness of Ricci's guess that it was none other than China. That after setting out from Kabul he crossed the Pamirs—being the first European to do so since Marco Polo—has long been an accepted fact (though doubted by Humboldt and Ritter), but it is impossible to be certain of his exact route, and Father Wessels does not entirely agree with Yule's suggested solution. From Yarkand (after a trip to Khotan, of both which towns, as also of the nephrite mines, there are interesting accounts) he took the route by the northern oases to Hami, and thence across the desert to Suchow, being the first modern European to reach China from the West. But "seeking Cathay he found Heaven," for he died at Suchow in 1607.

The next travellers of the series—Andrade and his immediate successors—have been much less generally known, and the research by which Father Wessels has succeeded in sweeping away prevalent misconceptions about them is perhaps the most valuable part of his labours. But as he had previously published his conclusions on the subject (cf. *Journal*, 40, p. 332), it is unnecessary to say much about them here. With a view to reaching the Christians supposed to be living in Tibet, the traveller went by way of Hardwar and the source of the Ganges (the route followed in 1807 by Webb and Raper) to Tsaparang in the valley of the Upper Sutlej, being the first European to cross the Himalayan range into Tibet. From the careful description of the place published in Calcutta in 1919 by Capt. G. M. Young, the author finds no difficulty in reconstructing the town as it was at the time of Andrade's visit. Francesco de Azevedo continued Andrade's work, and made a journey from Tsaparang to Leh, returning to India by the Baralacha and Rotang passes in 1640. But a more extensive journey was that of Stephen Cacella and John Cabral (1626–30), and the details given about this will be new to most readers. Entering Bhutan by way of Buxa, they made their way by Gyantse to Shigatse, whence Cabral returned to India through Nepal, being probably the first European to traverse that country.

The journey of John Grueber and Albert D'Orville (1660–1662) from Pekin *viâ* the Koko Nor to Lhasa and on through Nepal to India is much better known. By judiciously piecing together the scattered material yielded by sources of unequal value, Father Wessels has given as full a description of the journey as is possible, and in the task he has been aided by documents hitherto unpublished, and not used by Tronnier (cf. *Journal*, 24, p. 663). D'Orville did not give a very detailed description of his remarkable journey or of the town of Lhasa, but Hippolyte Desideri, who in 1714 travelled by Kashmir and Ladakh to Lhasa gives a very full account of Tibetan life and of the capital. The account was only discovered in 1876. Father Wessels' comparison of Desideri's and Younghusband's descriptions of Lhasa will be found particularly interesting.

The author remarks that he did not think it necessary to add a physical description of Central Asia, but he shows himself well acquainted with its geography, and by comparing the Jesuit accounts with those of recent explorers like Sir Aurel Stein and Sven Hedin proves clearly, in many instances, the remarkable accuracy of the former. The book represents a vast amount of research, and the references are very full. The author has spared no pains to clear up obscure points by inquiry in India and elsewhere, whilst also making the best use of the available literature, of which he gives a useful list.

The more important documents are printed in appendices, and an adequate map shows the routes of the travellers. A photograph of the Goes monument at Villa Franca forms the frontispiece. E. W. G.

Western Civilisation and the Far East.— **Stephen King-Hall.** London: Methuen & Co. 1924. *With three Maps.* 18*s. net.*

The writer of this remarkable book is a young naval officer who comes from a family well known in the annals of the British sea service. An earlier work, 'The diary of a German Submarine commander,' was written with such skill and naturalness that many even in naval circles were misled into thinking it really the work of a German officer. The volume under review deals with problems arising out of contact between the white races on the one hand and China and Japan on the other, and its object is to examine the most important phases of those problems from a distinctly *post-war point of view*—a fact which no doubt accounts for the somewhat pessimistic spirit in which much of it is written. A good general survey is given, in the second chapter, of the early conditions of the impact of the West on the East, but the main part of the book is devoted to the gradual rise of Japanese power in Eastern Asia and the progress of her policy and intervention in Chinese affairs on the mainland. One of the most interesting sections is that dealing with the rise of Socialism and the development of the Labour question in Japan. In this connection a significant and entertaining illustration is given of the control exercised by the police over the organization of Labour demonstrations as shown in the regulations issued for that of May Day 1921.

It is unfortunate that, in his survey of the policy of Western Powers towards China in the nineteenth century, the author fails to realize that, while it is undoubtedly true that the Chinese merchants, as a class, do largely deserve the honourable reputation they have gained, the officials—with whom he brackets them—really stand in a totally different category. Similarly his sympathy with China in her resistance to the intrusion of the Western Powers for the purposes of trade leads him to overlook almost completely the worst features of China's opposition—her bad faith, arrogance, and the frequent

encouragement of savage outbreaks against foreigners who were, for the most part, not only inoffensive but also helpless.

In contrast to this sympathetic attitude towards China, he has little sympathy or admiration for the very different methods adopted by Japan in her endeavours to meet the effects of Western civilization upon her ancient and isolated civilization. There is little or no praise for her efforts to fit herself for intercourse and competition with Europe and America, by the adoption of such Western ways as would enable her to meet them on equal terms ; nor is there any generous acknowledgment of the far-seeing vision and courage that led Ito and the other makers of modern Japan to risk, and sometimes to sacrifice, their reputations and their lives for their country's honour and welfare.

It is difficult, certainly, to justify the Japanese treatment of Korea, and the pressure upon Peking during the Great War at a time when China was helpless to resist and the hands of the Allies were tied. But we feel convinced the sentiment of an overwhelming majority of the people of Japan *was* opposed to this policy in spite of the writer's assertion to the contrary.

There are some pertinent observations on the loss of American prestige in China through "promising so much and performing so little," notably in what the writer terms "President Wilson's double-dealing with Japan at China's expense over Shantung Province." Equally interesting is the judgment expressed as to the secret of the respect enjoyed by the British, that it is because their "general principle of business and benevolence, with business first, appeals to and impresses the Chinese."

In spite of the blemishes—as we think them—above referred to, the book is well worth careful and sympathetic study, and though the historical statements are not always quite accurate, the author's conclusions are in the main very sound. One closes the volume in admiration for the industry, thoroughness, and intelligence displayed in its production, and we shall look forward with interest to further work from the same gifted writer. There are three excellent maps, of which one by an ingenious arrangement shows the virtual shrinkage of the world due to improved and accelerated methods of communication, while another indicates clearly the distribution of language in the different parts of the Chinese Empire. W. W.

AFRICA

Mysteries of the Libyan Desert.— W. J. Harding King. London : Seeley, Service & Co. 1925. $8\frac{1}{2} \times 5\frac{1}{2}$, pp. 384. *Sketch-maps and Illustrations.* 21*s. net.*

Mr. Harding King has at last given us an account of his journeys before the war in the Libyan Desert. He had already added much to our knowledge of the eastern parts of this area when the car patrols of the Western Desert Campaign commenced their wide-ranging reconnaissances, and one is therefore inclined to regret that the delay in publishing this volume was not accounted for by efforts to collate his information with more recent data. Of Mr. Harding King's adventures and his tribulations as a result of the intrigues of the Senussiya, we must leave the reader to learn at first hand ; they make good reading, though perhaps the best part of all is the account of the Egyptian Mamur's methods of dealing with the faithless guide who so nearly involved the author and his caravan in disaster.

The whole subject of topography and ancient routes is dealt with very objectively ; it is a pity that the scientific results bearing on the geography of the area are not incorporated in the form of an appendix. (They have appeared in various numbers of the *Geographical Journal.*) The reviewer,

for one, would have enjoyed hearing more of the results of the author's researches into the whys and wherefores of the many interesting things mentioned. Who were the builders of the ruins which he found? Who made the road down the descent of Gerara? What do Ptolemy and El Bekri say about the lost oases of the Libyan desert? In some respects, therefore, the book is very tantalising. We hear of repeated journeys by natives from Dakhla to Kufra, but little of the author's conjectures regarding their routes. The termination of the soft sand-dune belt south of Dakhla, with the implication that a route to Kufra was still practicable that way before the war, south of the point where Rohlfs made his attempt in 1874, is hard to reconcile with the vain efforts of the car patrols after the war to find a way westward from Dakhla. If both reports are accurate, one must conclude that the soft-dune belt has moved south at a very rapid rate in recent years.

It is interesting to compare the map based on native information gathered by Mr. Harding King with that compiled by Banse (*Petermanns Mitt.*, 1914, 1, Tafel 23), to a large extent from the same data. Both authorities have assumed that the name of the wadi whose headwaters are on the western slopes of Tibesti is Fardi, and that it eventually cuts the Jalo–Kufra route; Hassanein Bey and others, however, call the latter the Wadi Fareg. One would like to know on what grounds the two watercourses are identified, as one supposes that we have here the Bahr bela Ma which Rohlfs and others sought. It is a matter of considerable importance, for until its course has been determined it is difficult to reach a conclusion regarding the orography of the Libyan Desert.

In conclusion, it is only fair to state that had fortune been kinder to Mr. Harding King he would have rendered geography a much greater service than he was able to do in the course of his journeys, which, through no fault of his own, were not productive of sensational results. F. R.

Greater France in Africa.— William M. Sloane. New York: Scribner's. 1924. 8½ × 5½, pp. 311. *Map and Illustrations.* 12*s.* 6*d. net.*

To any one possessing an acquaintance with conditions in North Africa, this volume has little to recommend it, for it was written for the uneducated portion of the American public. It is the outcome of a propaganda tour on which the writer, in company with other members of an unofficial "commission," was conducted by the French Government to show these American citizens the more superficial side of the administration and resources of Algeria and Morocco. The title is misleading, for it does not deal with any but these countries and Tunisia. The first part of the book is devoted to a review of North African history. Many of the generalizations are hazardous; it is perhaps best not to examine them too closely. If all necessary allowances are made, the book may probably be said to serve its purpose. Any criticisms of the French administration are so slight as to leave the impression that they have been inserted largely for form's sake. It is only fair to admit that most of the good which the author writes of the administration is in fact borne out by the results hitherto achieved under the guidance of Marshal Lyautey. F. R.

AMERICA

Seeing Canada.— John T. Faris. London: J. B. Lippincott Company. 1924. 9 × 6, pp. 266. *Illustrations.* 30*s. net.*

This book was written "for the satisfaction of those who plan to travel in Canada or take up their residence there, as well as of others who, finding such

travel impossible, desire to have a view of the country of such tremendous possibilities." The author covers the ground from Cape Breton, "the front door of Canada," to Vancouver, "gateway to the Orient," in considerable detail. In a country of such great spaces he is compelled largely to follow the main routes, but he does not forget to recall the many claims of out-of-the-way districts upon the more ambitious traveller. He also outlines the epics of the early pioneer and colonist in that struggle which is still being carried on, and which has become so integral a part of the national life. It is obvious that he is aware that to neglect the people is to produce a picture of the country lacking vitality and breadth, but the nature of his work has probably prevented him from dealing with them more fully.

The Far West Coast.— **V. L. Denton.** Toronto: J. M. Dent, Ltd. 1924. 7½ × 5, pp. x. + 298. *Illustrations and Sketch-map.* 6*s. net.*

The exact intention of the writer of this book is a little difficult to grasp: it professedly is to relate "some of the halting steps which led to the present lusty youth of our Pacific littoral." It is not stated whether it is to be followed by a further volume: the present seems to halt between an account of the maritime exploration of the north-eastern Pacific coast and the relations of European countries to the whole ocean. It begins with the voyage of Juan de Fuca and his story of a north-west passage. The author then gives an interesting account of the crossing of Siberia by the Russians, attracted by the prospects of fur trading, and the adventures of Bering off the Alaskan coast and in the strait which now bears his name. Cook is the next to be treated of: all his voyages, though they have for the greater part little bearing on the subject, are described in considerable detail. The Nootka Sound controversy and the voyages of Vancouver complete the book. At that point travel on land begins to play a part. In spite of its disjointed nature, the book, dealing with less-known historical episodes, makes interesting reading.

The Arctic Forests.— **Michael H. Mason.** London: Hodder & Stoughton, Ltd. 1924. 9 × 6, pp. xiv. + 320. *Illustrated.* 20*s. net.*

This is another book which aims at dispelling the idea that the Arctic lands are necessarily barren and inhospitable. Mr. Mason spent two or three years in the valleys of the Mackenzie and Yukon, travelling, hunting, and prospecting. From first-hand knowledge often gained through bitter experience, he can write in detail of sledges, snow-shoes, packs, boats, and of all the hundred and one points which enter into the daily life of the adventurer in those regions. One pleasant trait he displays consistently, and that is his love of and care for his dogs. Then, too, he is a student of natural history, and opens his book with an ethnological survey of the Indian tribes, particularly the Takudh Kutchin of the Mackenzie delta. It must be admitted that what one learns from his book does not seem altogether to justify his high hopes for the development of the Northern Territories, expressed more especially in his chapter on "The Future Empire." Mr. Mason would reply that only a small fraction of its potentialites are already known—"but we all sing the same song of praise (and no one ever believes us)." However that may be, this book, practically the stories of life in the North, and the author's own travelling experiences it contains, should encourage others of the right sort to go out there and take a hand in the work. Nothing could be more convincing than the author's direct and unadorned tales of his struggles with nature under every kind of adverse condition.

AUSTRALIA AND PACIFIC

The Long White Cloud: Ao tea roa.— Hon. William Pember Reeves. 3rd edit. With a sketch of recent events in New Zealand by C. J. Wray. London: George Allen & Unwin, Ltd. 1924. 8½ × 5½, pp. 390. *Illustrations and Maps.* 16*s. net.*

This work on New Zealand—it is more than a mere history of the islands—has established itself as a standard authority, for the first edition was published in 1898. The reasons for its success are obvious: Mr. Reeves writes with affection of the natural beauties of his country, and of her history and present condition with understanding derived from practical experience, never allowing his enthusiasm to lead him to indiscriminate praise. Though New Zealand's history hardly extends over a century, it has gone through varied phases. Its early pages, before the declaration of British sovereignty, are filled with the doings of traders, missionaries, adventurers, such as de Thierry, the self-proclaimed King of New Zealand, and officials, among whom the well-intentioned Busby, with his scheme for a federal constitution for the Maori tribes, is prominent. Then came the years of nation-building begun not discreditably by the New Zealand Company, the instrument of the indefatigable Wakefield. How there grew up on this foundation a community characterized at this moment by advanced social institutions and true prosperity is a fascinating tale, and it is well told by Mr. Reeves and his collaborator. The book will undoubtedly stimulate interest in the rise, and confidence in the future, of this Dominion.

HUMAN AND HISTORICAL GEOGRAPHY

Ancient Hunters and their Modern Representatives.— W. J. Sollas. London: Macmillan. 1924. 9 × 6, pp. 733. 25*s. net.*

This well-printed and fully illustrated volume is the third edition of Prof. Sollas' well-known work, first published in 1911 as the outcome of a series of articles in *Science Progress*, the special theme of which was the attractive theory that the different races of Palæolithic man are represented in the world of to-day (or of quite recent times) by certain primitive peoples. Put shortly the correlation was: Eolithic man and the Tasmanians, Mousterian man and the Australian aborigines, Aurignacian man and the Bushmen, Magdalenian man and the Eskimo. The question naturally arises, how far has this theory been sustained or modified, since it was first produced, by the researches collected and expounded in this edition? It must be at once admitted that it has not gained but lost in force. The most ardent advocate of Eoliths cannot produce a vestige of evidence of what Eolithic man, if he ever existed, was like. Comparison is therefore restricted to the stone implements. Notwithstanding the championship of so distinguished an advocate as Sir E. B. Tylor, there seems no doubt that the Tasmanian artefacts were not Eolithic, but show rather Mousterian workmanship. No one, however, would venture to associate the Tasmanians physically with the Mousterians: they are obviously different races.

At first sight it looked as if in the Australian aborigines we had descendants of the Mousterians. A superficial likeness deceived many, and their culture until closely scrutinized seemed similar. But now Prof. Sollas sorrowfully admits that his former suggestion of the connection between the two races can no longer be supported. "The two races," he says, "belong to different species, and they differ not only in bodily structure, but in material culture as well." Next we come to the Aurignacians and the Bushmen.

Here it is easy to see how the suggested connection arose. The character and realism of Aurignacian art appeared to have a counterpart in the realistic cave drawings of the Bushmen. Moreover, the steatopygy of the Bushman women was reflected in some of the female statuettes of the Aurignacian Age. But unfortunately the typical Aurignacian man, the Cromagnon, to whom is attributed the artistic productions of the age, is the antithesis of the Bushman in physical character, and no anatomist would think of referring them to the same race. But the Cromagnon race does not exhaust the Aurignacian population. Examples of quite a different type from the Cromagnon have been found, showing Negroid affinities. They are attributed to a so-called Grimaldi race, thus named because the two first and best specimens were discovered in the Grimaldi cave near Mentone, though later finds at Piedmont in Moravia and at Combe Capelle in Perigord are referred to the same race. But there appears to be little or no evidence which justifies us in associating the fine Aurignacian art with the Grimaldi race. In the light of present knowledge, therefore, it is impossible to speak with any certainty, or even great probability, of the Aurignacians being to-day represented by the Bushmen.

Much the same difficulty, but in an enhanced form, arises when we come to compare the Magdalenians with the Eskimo. Meagre indeed is our knowledge of the bodily structure of Magdalenian man. So far as the evidence goes he appears to have been very much like his Cromagnon predecessor, though Prof. Sollas is convinced that the Magdalenians were new-comers, on the ground that there is a fundamental difference in their stone-working technique. Whilst, like the Aurignacians, he showed artistic talent, it was expressed chiefly in engravings with which the artistic work of the Eskimo may be compared. But comparison of their physical structure makes it impossible to regard them as being of the same race. One extraordinary and puzzling fact may be thought to connect Magdalenian man with the Eskimo. It is the skeleton discovered 5 feet deep in a Magdalenian deposit near Perigueux, in the commune of Chamelade. Out of it alone some anthropologists, with that craving for generalization now so prevalent, have been bold enough to construct a whole race. Certainly it is a most interesting specimen, and it strikingly supports, so far as a single example can do, the Eskimo theory. The similarity between the Chamelade skull and that of a typical Eskimo may be said to be complete; they are almost identical in every detail. There appears, however, to be nothing to associate the Chamelade skeleton with Magdalenian art, and it requires a bold and vivid imagination to evolve a whole race out of a single specimen. A sober scientific judgment cannot yet admit that connection between Magdalenian man and the Eskimo is proved. The author ventures further in another direction, and speculates on the possibility of the North American Algonquins being the descendants of Magdalenian man, who is supposed to have reached America either by the Icelandic ridge (it is extremely improbable that this survived sufficiently late for the purpose), or across Bering Strait, or by the plain that formerly covered its area.

The conclusion of the whole matter is that the more we know, the more accurate and critical our investigations, the more does the connection between the Palæolithic races of Europe and existing Primitive peoples elude us, and in no single instance can it be said that there is satisfactory proof of the existence to-day of representatives of any Palæolithic race. However disappointing this may be, the author has earned our gratitude for the lucid and interesting manner in which he has described the great Ice Age in its relation

to Early Man, and for the excellent sketches, replete with insight and sympathy, which he gives of the life and culture of the Australian aborigines, Bushmen, and Eskimo. E. A. P.

Zur Geopolitik der Selbstbestimmung.— Dr. K. Haushofer and **Dr. J. März.** Munich: Rösl & Co. 1923. $8\frac{1}{4} \times 5\frac{3}{4}$, pp. 504.

This somewhat remarkable volume is not a joint production, but is made up of two parts, for each of which one of the two authors seems to be solely responsible. That by Dr. Karl Haushofer, which forms the smaller but tougher portion of the volume, has the separate title 'Südostasiens Wiederaufstieg zur Selbstbestimmung' (South-East Asia's Reascent to Self-determination), and that by Dr. Josef März 'Das Schicksal Ueberseeischer Wachstumspitzen' (The Fate of Transmarine Advance Points). The first, after indicating the successive steps of encroachment by Western Europe and America on the populous part of the world with which it deals, lays stress on the signs of liberation from the external yoke and seems to regard these latter as unmistakable. The other treats of the footholds by means of which maritime powers have established and sought to extend their political domination or influence in any part of the world, not specially in South-East Asia, and in connection with this emphasizes the importance of the individual will in taking advantage, according to the circumstances of the time, of the geographical conditions presented (pp. 277–8); while the first places more in the foreground the influence of the geographical environment (p. 48). It is at first difficult to recognize any underlying unity which justifies the two being brought out within the same cover and under one general title, but an attentive reading of both seems to reveal the fact that both are agreed in the thought expressed at the close of Haushofer's treatise, that even though it may be true that eighty millions of people cannot be annihilated, cannot be utterly ruined, yet the example of South-East Asia shows that, in spite of all that it has achieved for humanity, of all its culture and philosophy, it may be robbed for decades and centuries of self-determination, but shows at the same time that even after centuries of oppression it can work its way up again by resolute will, provided only that the geographical conditions of that revival are fully recognized and constantly kept in view (pp. 161–2). Both parts of the volume make difficult reading. They are bad examples of bad German style. But this is specially true of the first section, which is all the more to be regretted, seeing that it swarms with ideas more or less worth consideration, though often very questionable. Both, on the other hand, have the merit of being well documented and, so far as the present reviewer has observed, accurate, apart from two or three oversights in proof reading. There is a bibliography for both sections and a good index in which the more important references are distinguished by heavy type. G. G. C.

GENERAL

(1) **Elementary Commercial Geography.— H. R. Mill** and **F. Allen.** Cambridge University Press. 1924. $7\frac{1}{2} \times 4\frac{1}{2}$, pp. x. + 194. 4*s.*

(2) **Australia and New Zealand.— B. C. Wallis.** London: Macmillan & Co., Ltd. 1924. $7 \times 5\frac{1}{2}$, pp. x. + 350. *Maps and Illustrations.* 6*s.*

(3) **The New Regional Geographies.— L. Brooks.** London University Press. 1924. North America. $7\frac{1}{2} \times 5$, pp. 178. 2*s.* 6*d.* Central and South America. Pp. 68. 1*s.* 6*d.* *Maps and Illustrations.*

(4) **Africa.— E. Lewin.** Oxford: Clarendon Press. 1924. $7\frac{1}{2} \times 5$, pp. 224. *Illustrations and Maps.* 3*s.*

(5) **A Canadian School Geography.**— **G. A. Cornish.** London and Toronto: J. M. Dent & Sons. 1922. $7\frac{1}{2} \times 5$, pp. xiv. + 450. *Maps and Illustrations.*

(6) **Geography: Physical, Economic and Regional.**— **J. F. Chamberlain.** London: J. B. Lippincott Co. 1924. Second edition. $7\frac{1}{2} \times 5$, pp. xviii. + 510. *Maps and Illustrations.* 15*s.*

Of the writing of school books there seems to be no end, and geography has its full share. All these books have two aspects in common. They are mainly or solely regional in their treatment, and while some devote more space than others to physical phenomena, attention is mainly focussed on human problems.

(1) Dr. Mill and Mr. Allen have brought out a fifth edition of a small book that was virtually a pioneer among such volumes when it first appeared in 1888. The small size of the book necessarily entails great condensation, but the scope is wide and the matter well arranged. A very full index and the use of varied type enhance the value of the book to the student.

(2) Mr. Wallis' book is one of Macmillan's series of modern geographies. The author shows his partiality for statistical matter, which certainly gives precision to the study. Some of the maps are ingenious and striking, and all are clear and useful. The same applies to the well-chosen illustrations. The book is full and accurate, but more stress might have been laid on the population problem and the question of a white Australia.

(3) The books by Mr. Brooks are new editions in sections of the larger book on the Americas in the same series. The treatment is regional throughout. Physical considerations are introduced in their due place in the study, and historical geography is not overlooked. The material is wisely selected and the book is not overloaded with detail. The causal relations between rainfall and elevation might be made clearer (p. 41).

(4) Mr. Lewin's volume is one of the first of a new series of Certificate Geographies designed for the use of pupils preparing for the Higher Certificate. The treatment is mainly continental, and, as might be expected from the author, the book is a mine of precise information on Africa. But it is rather a small encyclopædia than a text-book. Some of the chapters, such as those on communications and towns, contain a mass of facts that might well bewilder any unfortunate pupil who was expected to master them.

(5) Prof. Cornish's volume, for which an atlas with maps by Bartholomew has been prepared, should do much to improve the teaching of geography in Canada, where the subject so far has scarcely got due recognition. A short introductory section deals with the principles of physical geography, but the greater part of the book is devoted to the regional treatment of Canada and the United States. The rest of the world is a mere sketch. Economic considerations loom largest, and there is room for improvement in the physical chapters. Low-pressure areas are described at the poles, which is rather out of date, and in several cases, *e.g.* in the Balkans, the effect of avography or human movements, is not sufficiently emphasized. The illustrations and maps are numerous and admirably chosen and reproduced.

(6) The important place that geography holds in American education is reflected in this large text-book. It covers far more ground than any secondary school book used in this country, although the regional treatment is confined to the United States. The physical introduction is sketchy, and there is the common mistake of low-pressure areas at the poles, and some confusion between pack ice and icebergs. As usual in American books, economic geography

receives fullest treatment. The diagrams and illustrations are useful and well chosen, but the coloured maps with one exception are poor. Many references are given, almost entirely to American works. In spite of any defects it has the book is certainly interesting and informative.

Round the World.— F. Hedges Butler. London: T. Fisher Unwin 1924. 9 × 6, pp. 270. *Illustrated.* 21*s. net.*

Mr. Hedges Butler, possessed of a passion for long journeys, is content with nothing less than a circuit of the globe for each trip. His book contains a narrative of three world tours. However satisfying they may be to him, it is difficult to make the accounts of such sudden sallies of interest to his readers. The first journey he describes is typical of the remainder. He passes rapidly across America to the Hawaian Islands, which he describes at some length in a style something reminiscent of the guide-book. These chapters, however, raise the hope that more detailed study will be devoted to lesser-known spots; but the notes on Japan and China are scrappy, and thence onwards it becomes difficult to keep pace with the author. In Ceylon we set out with him after a rogue elephant, when suddenly without warning we are back in Colombo, preparing for the homeward dash, having been round the world in eighty pages.

Reisen und Abenteuer. Unter den Rothäuten: **Prinz Max zu Wied.**— Hochtouren im Tropischen Afrika: **Hans Meyer.**—Auf den Inseln des ewigen Frühlings: **Arthur Berger.**—Jäger des hohen Nordens: **Vilhjalmur Stefansson.** Leipzig: F. A. Brockhaus. 1923–4. 7½ × 5. *Illustrations and Sketch-maps.* 3 *Swiss francs each.*

These are the volumes already received of a new German series in which thirty have appeared. The series is similar in plan to that dealing with historical exploration noticed in the *Journal* for May (p. 463). As before, each volume contains sketch-maps, illustrations, etc., consistent with the low price. In most cases the text has been abridged and translated from standard works. Stefansson's book is a condensed version of his 'Hunters of the Great North,' and 'Hochtouren im Tropischen Afrika' is a collection of Meyer's sketches from various sources. On the other hand, Berger's 'Auf den Inseln des ewigen Frühlings,' which deals with a visit to, and the history of, the Hawaian Islands, appears to have been written specially. The initiation and scope of the series are evidence of the interest taken in Germany in the wider world.

THE MONTHLY RECORD

EUROPE

Forms of Settlement in Hungary.

Dr. Gyula Prinz has given a careful study of the forms of settlement in Hungary in the *Ungarische Jahrbücher*, Band IV. Hefte 2–4, 1924.* The actual origin of all but the newer settlements is lost in obscurity, but by studying the ground-plan of the villages on a large-scale map (the author has used

* This is a high-class journal started apparently since the war under the auspices of the Hungarian Institute of Berlin University, and devoted to Hungarian History, Ethnography and Geography. It is edited by Dr. Robert Gragger of the said Institute, and published by the Berlin firm of Walter de Gruyter & Co.

the Austro-Hungarian 1/75,000 map, from which he reproduces many examples of actual villages), it is possible to lay down certain general types, and to trace their distribution over the country. Although many parts show a mixture of forms, in others there is a well-marked line of partition between the types, due, it may be, to geological or ethnological factors. The writer follows in the main the classification used by German writers on the subject, the three main types being known as the *Haufendorf* (signifying a village formed by a natural process of agglomeration from originally scattered elements ; it might perhaps be rendered by "clustered village"); the *Runddorf;* and *Planmässige Dörfer*, or villages laid down on an artificial plan, themselves divisible into various sub-classes. In the process of agglomeration of scattered elements relief probably exercises a chief influence, for in long narrow valleys the concentration will be into continuous strips, in broader ones into more isolated groups. The most interesting element in Hungarian settlements is afforded by the large clustered villages of the Alföld lowland. They may be considered the most typically Hungarian of all, and their plans closely resemble those of the cities of Turkestan. One group is characterized by the radiation of streets from a common centre—the market-place—and an original circular form is due (as in Jaszapáti) to the protecting wall, to which the outer ring of streets also owes its origin. Sometimes (as in Hajdú-Böszörmeny) there is a double ring, betokening an outward extension in course of time. The main roads converging on the place are continued without a break to the centre, though they sometimes bifurcate before reaching this, giving the place something of a star-like form. Compactness is a general characteristic, due to need of protection, and in the low-lying area of the Theiss to the desire to escape inundation. The secondary network of streets seems at first entirely without system, but is probably inherited from the primitive paths by which the husbandmen reached their houses in the most direct way possible. A variety of this main type is that in which the arrangement is fan-shaped instead of radial. Another main group is formed by the *Wirrhaufendorf* or irregularly clustered village of the Wallachians of Transylvania, where no system at all is traceable in the street-plan, and the houses are massed with no reference to the form of the ground. Veléte, for instance, occupies eight mountain ridges, making no attempt to spread over the level plain at the edge of which it is placed, and its network of streets is quite haphazard. The village of the Széklers differs somewhat from that of the Wallachians in being more loosely compacted—a reflection of the independent character of the race—and it is more influenced by the nature of the terrain. Various other types are described, among them the street-village, by which is denoted not the village built along the course of a highway (for it is often quite remote from such), but one built in two continuous rows of houses, leaving space for a street between ; and the *Rynkdorf*, or village built round a quadrangular open space. In conclusion the author sketches the regional distribution of the several types and illustrates it by a map.

ASIA

Our Map of Bhutan and Southern Tibet.

It has been pointed out to us that the statement on this map, given in the *Journal* for October 1924 to illustrate Major Bailey's paper in the same number, that it was made "from Surveys by Major F. M. Bailey and Captain H. R. Meade" was inaccurate, inasmuch as practically all the survey work was done by the detachment from the Survey of India which accompanied

the Expedition. In gladly making this correction we ought to point out that this fact was made quite clear by Major Bailey himself in his covering letter to the Editor, in which he expressly disclaimed personal credit for any but a small part of the map. The principal survey work was done by Capt. Meade and Surveyor Bansi Ram.

Human Geography of the Malay Archipelago.

An instructive sketch by Robert Eichelberger entitled "Regenverteilung, Pflanzendecke, ard Kulturentwicklung in der ostindischen Inselwelt" appears in the *Geographische Zeitschrift*, 2 Heft, 1924, bringing out the close correspondence between abundant rainfall, heavy forest growth, thin population and low culture, on the one hand, and relatively scanty rainfall, light vegetation, dense population, and high culture on the other. A map showing the distribution of vegetation types in the Malay Archipelago very faithfully reflects the distribution of rainfall shown in another, the tropical evergreen lowland and mountain forests flourishing in regions of heavy rainfall either of the equatorial or monsoon type (as nearly throughout Sumatra, Borneo, and western Java), whilst savannah, steppe, xerophilous scrub, and deciduous monsoon forest occur in east Java, south-east Borneo, Flores, Timor, Sumba, Sumbawa, and parts of Celebes and the Moluccas. The relationship between rainfall and vegetation is governed less closely by the actual average yearly amount of rain than by its seasonal distribution, but evergreen tropical forest cannot flourish with an annual quantity below 1800 mms. (72 inches), and if it is to flourish under monsoonal conditions the "dry season" must not be rainless. The amount and frequency of rain, both of the equatorial and monsoon type, are, as in other parts of the world, conspicuously affected by orographic relief, whilst within the same rainfall region subsidiary differences in the vegetation are controlled by geological factors—in the manner which commonly holds in Europe, and is nowhere more instructively illustrated than in the south-east of England where parallel geological outcrops of similar elevation in Kent, Surrey, and Sussex bear distinctive types of vegetation. Similarly, the general correspondence between dense rain-forest and a low grade of human culture, and between open country and a higher political status, is locally interfered with by extraneous economic factors, as, for instance, in the Moluccas, which have long been so dominated by the spice trade, leading to the establishment of coastal or island states, that inland development has been neglected, notwithstanding much open country favourable to settlement. Celebes is extraordinarily variable in its interior conditions of rainfall and vegetation, densely forested mountain ranges separating, and cutting off from intercommunication, stretches of open settled country, and this factor has been conducive to a marked degree of national differentiation. In Celebes there are said to be thirty-two branches of the Toraja race from which many different political organizations have sprung, recalling the state of things in central and south Germany, where a similar physical diversity has been associated with like ethnic diversity. Java is the great cultural and economic centre of the East Indies, all other islands lagging far behind. Position, climate, vegetation, fertility, and other favourable conditions led to the very early settlement of the island, trading with India taking place at the beginning of the Christian era. The open lands of central and eastern Java offered themselves readily to the penetration of foreign influence, and powerful Hindu, and later Hindu-Javanese, realms arose, chief among them the Modyopahit, which extended its influence eastward to Bali and Lombok and

founded a daughter state in south-east Borneo, where physical conditions of rainfall and vegetation resemble those of eastern Java.

AMERICA

The Mount Logan Expedition.

A strong party of eight, under the leadership of Mr. A. H. MacCarthy, has been organized by the Alpine Club of Canada to attempt the ascent of Mount Logan, in the south-west corner of the Yukon, and about 21 miles east of the international boundary. This mountain, named after the first director of the Geological Survey of Canada, was photographed from the south by the Duke of the Abruzzi's expedition in 1897, but its commanding height of about 19,850 feet was not fully established until the survey of the boundary in 1913. Last year Mr. MacCarthy made a reconnaissance of the approaches from the west, and chose what seems to be a feasible though very long route to the summit. In the early spring of this year he was already in the field laying out depôts up the Logan Glacier, and the main party were to leave Seattle for Cordova in Alaska on May 2. From Cordova the Copper and North-Western railway will take them to railhead at McCarthy, whence it is about 80 miles up the Chitina valley to the foot of the Logan Glacier, and then 50 miles up the glacier to the foot of the King Glacier ice-fall, where the advanced base will be established at about 8500 feet. From this camp to the summit is about 16 miles. To those who think in terms of Mount Everest the heights are insignificant, but the distances great; and the weather is not likely to be good.

In response to an appeal for funds from the Alpine Club of Canada our Society has subscribed 500 dollars, and we have been promised the geographical results of the expedition for publication in the *Journal*. The expedition hopes to return to Seattle early in August. We shall await with great interest the result of this first attempt to climb the highest mountain in British North America.

Col. Fawcett's Expedition to Central Brazil.

Col. P. H. Fawcett, well known for his surveys on the boundaries of Bolivia, Peru, and Brazil, has started on a new expedition into the most remote recesses of South America in fulfilment of a project which he has had in mind for some years, and which he made a first attempt to carry out in 1920. Writing to us on March 7 last from his final "stepping-off point" at Cuyaba in Matto Grosso, he was able to report that all preliminaries had been successfully arranged, thanks largely to the good offices of the British Minister, and the interest in the expedition shown both by the Brazilian Government and by scholars of that nation. Besides geographical exploration, the main objects of the expedition are antiquarian and ethnological research. Col. Fawcett has long held that traces of lost early civilization may still be found in the forests of the interior, and he cites in support not only the chaos of buried stone representing an old city near the borders of the State of Piauhy, visited by Col. O'Sullivan Beare and himself, but other recent discoveries, including that of a vast wall some leagues in circumference said to surround the sites of seven prehistoric settlements connected with each other, also in Piauhy. In his view, in which, he says, Brazilian geologists are disposed to concur, this part of the continent was formerly broken up into several distinct land masses, the sea also running into the mainland up to the western border of the present State of Bahia, so that the sites of the supposed

old cities would then be on the coast-line. The river Indians at the present day are for the most part a degenerate lot, and Col. Fawcett considers it most misleading to base our ideas of aboriginal South America upon these. In Matto Grosso reports are current of the existence of tribes of ferocious pigmies, said to be black and hairy, with extremely short necks like gorillas, and he hopes to make a comprehensive study of these people. The Europeans of the party consist of Col. Fawcett himself, his son, and Mr. R. Rimell, all being fit and well, and capable of great endurance. Two hired men will help with the mules for the first part of the journey—as far as Col. Fawcett penetrated in 1920, roughly 12° S.—but, owing to the fear inspired by the bad Indians, their services would have to be dispensed with beyond that point.

HUMAN AND HISTORICAL GEOGRAPHY

The "Columbian" World-Map in the Bibliothèque Nationale.

It was not to be expected that so venturesome a theory as that put forward by M. de la Roncière, that the map in the Bibliothèque Nationale recently brought to light is the work of Columbus (cf. *Journal*, March 1925, pp. 247–251), would pass without severe criticism, and such has already been forthcoming from the very official in whose keeping the map rests—M. Albert Isnard, Keeper of the Map Department at the Bibliothèque Nationale. In an article contributed to the *Revue des Questions Historiques*, he submits M. de la Roncière's theory to a searching examination, and reaches the conclusion that the arguments used by the latter are either without importance or opposed to known facts. More than this, he holds that the map presents features which make it impossible that it could have been used by Columbus in support of his proposals to the Spanish Sovereigns. M. Isnard's objections seem at least deserving of careful consideration. The supposed indications that the author was a Genoese are held to be valueless. The *Rio de Jenoves* is to be found also in the Cantino map drawn at Lisbon, and the drawing of Genoa is so like that on the Portolan of Freducci of Ancona (1497) that both are probably derived from a common source. Again, while Columbus confused the Færoes (Frixlanda) with Iceland (Tile), the maker of the map did *not*, and therefore is not likely to have been Columbus. The argument based on the use of the *Imago Mundi* of D'Ailly both by Columbus and the maker of the map is held to be of little value in view of the popularity of that work at the time, and it entirely falls to the ground if we accept the views of Vignaud and Harrisse that the original owner of the copy—Bartholomew Columbus—only rejoined his brother in 1494, after a separation of at least eight years. If therefore the map reflects the opinion of Columbus on the doctrines of D'Ailly it cannot have been drawn before the end of 1494, and cannot possibly have been used in furtherance of his project of discovery. The common use by the navigator and cartographer of the solecism *de ibi*, which seemed to many M. de la Roncière's strongest argument, is held to be without the weight attached to it, as two individuals without literary training, and living in a similar milieu, might quite well both translate *de là* by *de ibi*.

Passing over one or two points of less importance, we come to the supposed representation on the map of Santa Fé and Granada, and here M. Isnard's objections certainly appear cogent. In Portolan maps intended for practical purposes it was the maritime cities that were naturally shown most prominently, and by name. They are also always drawn as seen from the sea. Now, as pointed out in our notice in the March number, the city supposed to be Granada is drawn as seen from the north; and while we look in vain for

the name Granada on the map we do find that of Bilbao just opposite the central gate in the drawing. Similarly, over against the centre of the town supposed to be Santa Fé (drawn as seen from the south) we find the name Elmeria, and we notice also that the place is shown as lying within a rampart of mountains, just as Almeria does in reality. If, moreover, the larger town were Granada, why is the Spanish flag shown as flying from its walls early in 1492? Some of M. Isnard's further points have already been hinted at in our previous notice, but he lays special stress on what he considers the entire insufficiency of the map in the Bibliothèque Nationale to illustrate the proposals of Columbus, since the one indication of land to the west is in a latitude entirely different from that in which the navigator thought to find it, and, as a matter of fact, did really find it. On the other hand, the full nomenclature on the coasts of the Mediterranean and Eastern Atlantic gives some reason for supposing it made for the use of those sailing those seas.

We shall endeavour to follow with impartiality the developments of what promises to be an interesting controversy, for we understand that M. de la Roncière is preparing a reply to the above objections of M. Isnard.

A Sicilian Geographer of the Seventeenth Century.

In a communication to the Ninth Italian Geographical Congress, held at Genoa last year, Prof. F. S. Giardina called attention to the work of a Sicilian geographer whom he thought worthy of being rescued from the oblivion into which he has fallen—Giambattista Nicolosi. The paper, which has been printed in the *Bolletino* of the Italian Geographical Society (Ser. VI. vol. I, N. 7–8, 1924), gives a useful sketch of the scope and contents of the various works of which Nicolosi was the author, but which are now known to but few. Born at Paternò in 1610, Nicolosi afterwards migrated to Rome, where he died in 1670, having been held in high esteem by his contemporaries for his proficiency in languages, literature, mathematics, and military art, but above all as a cartographer and geographer. In 1652 he was charged with the making of ten large maps for the 'Propaganda Fide,' and soon afterwards undertook for Alexander VII. and the Emperor Leopold the mapping of the States of the Church and the Kingdom of Naples, besides making five large maps for Prince Borghese. His published geographical treatises were three: (1) 'Teoria del Globo terrestre,' in which he adopts the tripartite division of the subject into mathematical, physical, and political geography, usually credited to Varenius. Although in his unpublished works he showed leanings towards the new views of Copernicus, he does not here venture to break away from the Ptolemaic system, no doubt owing to his character as a devout son of the Church. (2) 'L'Ercole Siculo, o Studio Geografico' (published both in Latin and Italian), of which the first volume was principally occupied with a detailed description of the countries of the world, while the second formed an atlas of twenty-two maps—two of the hemispheres, and four devoted to each of the five continents. In this atlas he makes use of the globular projection, and even if he cannot be credited with its first invention, it seems that it owed its subsequent popularity to his adoption of it. (3) 'Guida allo Studio Geografico,' a small work designed to supplement and explain the other two: one chapter treats of the construction of globes and maps. The unpublished MSS. include detailed descriptions of the Papal States and the Kingdom of Naples, accompanied by maps; accounts of the coast regions of Spain, and of a journey to Germany; and various other studies.

GENERAL

Early Maps of the British Dominions.

The small exhibition of early maps of parts of the British Empire, arranged by Mr. Sprent last summer at the British Museum with a view to interesting Colonial visitors (see *Journal*, vol. 64, p. 269), has been considerably extended this year by the inclusion of maps and views relating to India and Africa. It is again to be seen in the King's Library. The most important early map of India is William Baffin's 'Indolstani . . . Descriptio' of 1619, of which the British Museum copy appears to be unique. It was long known generally as Sir Thomas Roe's map, and (as pointed out by Sir W. Foster in his edition of Roe's voyage) was no doubt based on information collected by Roe and placed in Baffin's hands, that distinguished navigator having been master's mate on board the ship in which Roe returned from India. Views of Indian cities include (among others) Calicut (the first Indian port with which Vasco da Gama had dealings), taken from Braun and Hogenberg; Surat and Bombay, from Baldaeus; Madras, as shown in Salmon's 'Modern History,' 1744, the year in which Clive first landed in India; and Calcutta, by W. Baillie, 1794. In the African section we find the map given in the rare 'Itinerarium Portugallensium,' printed at Milan in 1508 (thought by Nordenskiöld to have served as the prototype for many of the maps of Africa current in the sixteenth century); that of Ramusio, from the middle, and of Linschoten, from the end, of the same century; a view of El Mina, as the first European settlement on the coast of Guinea; and a map taken from Sparrmann's travels in South Africa at the end of the eighteenth century. Some of the most famous maps in the other sections were mentioned in our notice last year, but a few further notes may be given here. The North American section of Ortelius's very rare world-map of 1564 is remarkable as applying the name Canada not to a part of the mainland, but to one of several large islands occupying the position of Newfoundland. A more accurate picture is supplied by Lescarbot in 1609, whilst the map in the first edition of Champlain's voyages (1613) gives a very fair representation of Hudson bay and marks the southern portion as "the bay where Hudson did winter"—an interesting instance of prompt appearance on a map of an authentic item of news, Hudson's wintering having been in 1610–11. The earliest view of Niagara is supplied by Hennepin's 'Nouvelle Découverte' of 1697, whilst the Siege of Quebec and battle of the Heights of Abraham are illustrated from Thomas Jefferys's 'Natural and Civil History of the French Dominions in . . . America.' The oldest British colony, Newfoundland, is well represented, the maps shown including one of 1626 made by Capt. John Mason (published in Vaughan's 'Golden Fleece'), and that of 1775 showing the results of the survey by Captain Cook and Michael Lane. In the West Indies some of the earliest English colonizing ventures are illustrated by maps of Barbados, from Ligon; of St. Kitts, from Du Tertre's 'Histoire général des Antilles . . .,' 1667–71; and of Tobago, by John Seller, 1685. Altogether the exhibition gives an excellent general view of the gradual evolution of the maps of the British Empire down to early in the nineteeth century.

Exhibition of Road-maps at the Paris Geographical Society.

Sir George Fordham, whose unique collection of maps and other geographical publications of John Cary and his successors was exhibited at the Society's house last year (*Journal*, vol. 63, p. 438), has this year arranged a general exhibition of early road-maps in the library of the Paris Geographical

Society, where they were on view in April and May. It illustrates the development of this special kind of aid to travellers from the beginning of the sixteenth century down to the present day. Special attention was drawn to the quasi-official system of route-books and maps produced in France early in the eighteenth century, and to the splendid work done somewhat later in that country by a State Department, the cartographical output of which permitted the issue by private firms of route-maps for the use of the Court and of travellers. Among the most interesting exhibits were the road map of Germany of 1501 (based on an earlier example known by its heading 'Das ist der Rom-Weg'); Symonson's map of Kent of 1596, with roads clearly marked; various examples of the "strip" maps of English roads by John Ogilby in the seventeenth century; the 'Liste générale des Postes' of France of the second half of the same century; the 'Indicateur Fidèle' of Michel and Desnos; and the Itinerary prepared for the journey of the Court from Paris to Reims in 1775 by Dom Coutans, and the sheets of his Atlas of the Environs of Paris brought out by Piquet in 1800. The series was closed with a beautiful modern map of the French roads, etc., produced in 1843.

OBITUARY

General the Lord Rawlinson, G.C.B., G.C.S.I., G.C.V.O.

LORD RAWLINSON was the eldest son of Major-General Sir Henry Rawlinson, Bart., the distinguished Oriental traveller, and President of our Society from 1871 to 1873 and from 1874 to 1876. He succeeded his father in the Baronetcy in 1895, and in the same year joined our Society.

By his death towards the close of his term as Commander-in-Chief in India the Society loses one of its most distinguished Fellows, and one who among his numerous activities retained always a special interest for anything pertaining to Geography. The geographical and topographical aspects of military operations were invariably studied by him with meticulous care and extraordinary insight. In his preparations for the Somme battle in 1916 he included an unusually elaborate programme of cartographical work—a programme, it may be said, too ambitious in some respects for the resources then at his disposal. To the development of geographical work which ensued as the result of the fighting he gave an unremitting attention.

He was a keen student and a discerning critic of anything connected with maps and surveys, and throughout the battle found time to examine personally every single aerial photograph taken of the enemy's positions. The colossal nature of this task will be evident when it is stated that the average number of photographs taken daily ran into hundreds. Nor was this examination perfunctory. It was the duty of an officer specially to examine the photos beforehand and to bring to his notice any new German defences visible on them, and it is a fact that not once, but many times, did Lord Rawlinson himself detect trenches and other features which had escaped the notice of his subordinate. So keen was his examination and so caustic were his comments on any such omissions, that the officer in question regarded his nightly visit to the Army Commander's room with no small trepidation.

Although in many respects a hard master, Lord Rawlinson's character inspired, and personality inspired, affection at least equally with respect. His personal staff both loved and admired him. His judgment was unquestioned

and his decisions unmistakable; when to this is added a resolute will, a keen sense of humour, and a fine physique, one has the picture of a great soldier and a great man well fitted to bear the laurels of his achievements.

M. N. M.

Sir Alexander Hosie.

By the death of Sir Alexander Hosie the Society loses one of its oldest and most valued members. It may be questioned whether any European, unless it were his friend, General Pereira, had travelled so widely in China, and few have looked upon its products with so observant an eye or written upon them with so accurate a pen. From the coast to the Tibetan frontier, from Mongolia and Manchuria to the borders of Annam, he traversed every province save that of Sinkiang, ever keenly attentive and carefully recording from day to day whatever of value came under his notice. But it was as a resident British Consul that he made his more intimate studies of the products and trade of the country. His periods of residence along the coast in Canton, Swatow, Formosa, Foochow, Wenchow, Shanghai, Chefoo, Tientsin and Newchwang, and in the interior at Peking, Chengtu, Kinkiang, Wuchow, and Chungking (where he saw no European for nearly three years) enabled him to study with unflagging diligence the characteristic products of those widely separated areas. His researches were embodied in official reports of unusual merit. His two books, 'Three Years in Western China,' 1899, and 'Manchuria: its People, Resources and Recent History,' 1901, are still among the standard authorities on those two regions.

It was in 1902 that he was made the first Consul-General of the Province of Szechuan, and exactly three years later he became Acting Commercial Attaché, an appointment which gave him an opportunity of doing the work he liked best. Of his reports of 1904–5, 1906, and 1907 it has been said that they "will long continue to be the standard of what such work should be." In 1908 he was appointed British delegate to the Opium Conference in Shanghai, and contributed for its consideration a treatise at once recognized as of the first importance. In 1910 he was sent as Special Commissioner to inquire into the reduction of opium cultivation. His duties involved him in travel of the most arduous description through the intense heat of summer. After prolonged absence and traversing thousands of miles of country the fine strong man who set out returned a physical wreck. His sound constitution enabled him to recover, but he retired from the Service in 1912. In 1915 he published a remarkably able work on opium, valuable also for its detailed information regarding the agricultural and mineral products of the interior provinces. In 1919 he paid his last visit to China for the study of an important article of commerce, and while there was pressed into temporary service as Special Attaché in Peking. Soon after his return home his right foot, severely frozen on one of his journeys, had to be amputated, and he never recovered his strength.

He had planned and begun work on an Economic Dictionary of Chinese Products, a task which, almost before he realized it, led him to apply himself to the preliminary production of a Commercial Map of China. This, with its elaborate index, he was able to complete and publish, aided by his devoted wife.

Great though his services were to economic geography—a subject which was his ruling passion—they were perhaps equalled by his high qualities as an administrator. His justice to all, irrespective of nationality, was every-

where recognized. His services to the Chinese, under difficult circumstances, evoked a unique dispatch of thanks from their Government. Beloved and trusted by his intimate friends, he has left an example of integrity, of diligence, of self-sacrifice, and of loyalty worthy of the highest traditions of the great Service to which he was proud to belong.

To this *Journal* he made several contributions, and more than once lectured to the Society. It is probable that his first journeys would have attracted still greater attention had they not been made at a time when the number of distinguished travellers competing for geographical honours was unusually large.

Born at Inverurie January 16, 1853, he was educated at the Grammar School, Old Aberdeen, graduated at Aberdeen University in 1872, joined the Consular Service 1876, was knighted 1907, and made Hon. LL.D. of his university 1913. He married first, in 1877, Florence Lindsay, by whom he had a son; and second, Dorothea (daughter of Prof. Soothill of Oxford University), whose book 'Two Gentlemen of China' was reviewed in this *Journal* last year. He died 10 March 1925.

CORRESPONDENCE

The Great Barrier Reef.

In the *Journal* for April, Colonel Sir Gerald Lenox-Conyngham accepts the view previously adopted by Forbes, Agassiz, Vaughan, and others, that the Great Barrier reef of Australia has recently grown up in the warm waters along the north-eastern or Queensland coast from a relatively shallow foundation provided by the previously formed continental shelf, which is seen without a reef upon it in the cooler waters of the south-eastern or New South Wales coast.

The alternative view—essentially that of Darwin and Jukes—presented in some detail in the *American Journal of Science* for 1918, deserves consideration at least, as the following points will show. First, the shifting sands and silts of a continental shelf do not offer a good foundation for reef-builders. Second, it is just as possible for a barrier reef with its enclosed lagoon and a continental shelf without a reef to have occupied adjoining stretches of the Australian coast in former times as it is for them to do so to-day: one is an organic structure and the other is an inorganic structure, but they may nevertheless be developed alongside of each other; the boundary between them may well have fluctuated in the past with changes of climate during the Glacial period; and the shelf may slowly gain on the reef to-day as well as at certain earlier epochs by the northward advance of sand deposits in a debatable intermediate belt: but the two structures may have long co-existed on the eastern coast. Third, the "differential movement" of the coast that has long been in progress, as pointed out by Andrews in 1902—"the coastal area sinking, while inland there was elevation"—offers precisely the condition for the establishment of a barrier reef along a line "that was formerly the coast of the mainland"; and it would appear that the rate of submergence since then has not been too great to be compensated by reef upgrowth, because a great amount of low-grade

erosion has been accomplished on the mainland in the same period; the occurrence of a good number of atolls in the Coral sea which fronts the Queensland coast gives some confirmation to this idea. Fourth, the view that reef growth was not established on this coast until its submergence was far advanced and the present continental shelf was essentially completed along it excludes, without reasonable warrant, the possibility of earlier establishment, as just suggested; nevertheless, it is eminently possible that reefs may have been earlier established, as is well shown in Fiji, where some of them were begun so long ago that they have experienced, since their beginning, a long period of upgrowth during subsidence, a long period of erosion during elevation, and now a second period of subsidence, during which a stalwart new reef has grown up on or around the eroded remains of the older reef. Fifth, no reason is advanced to show why the establishment of the Barrier reef should have been so long delayed: it is plain that if it could have lately begun its upgrowth where the depth of the shelf and the temperature of the ocean water were fitting, it might have begun long ago under similar conditions; for during the progressive sinking of the former land border and the associated upbuilding of the continental shelf, there must always have been belts along it that were as well fitted for reef growth as they would be to-day. In view of these five points, an early origin of the reef seems at least permissible if not plausible; and the adoption of a recent origin for it does [not] seem compulsory.

But there is a sixth point to be mentioned which seems to me much more favourable to the idea of ancient than of recent reef-origin. If the entire eastern border of Australia had been reef-free until recently, the coast ought to be as well cliffed along its northern half as it is along its southern half; but it is not. The charts make this fairly clear; the views that I had of various stretches of the northern and southern coast in 1914 made it, to me, clearer still. Much of the cliffing now seen along the southern coast was done before its recent slight increase of submergence (and hence before its later and still slighter emergence), at about the time when the shelf theory of the Barrier reef would date its beginning. No similar cliffing has taken place on the northern coast; hence that coast must have been then, as now, protected from the attack of ocean waves by such a breakwater as the reef would have furnished. None of the above-named students of the Barrier-reef problem have taken this point into consideration; and they have, indeed, given very scanty, if any, consideration to the other five points above noted. Their adoption of the shelf theory therefore seems unwarranted. The problem is still much more open to discussion than readers of the April *Journal* may have been led to suppose.

W. M. DAVIS.

Harvard University, Cambridge, Mass.,
May 1925.

MEETINGS: ROYAL GEOGRAPHICAL SOCIETY: SESSION 1924–1925

Twelfth Evening Meeting, 27 April 1925.—The President in the Chair.

ELECTIONS.—Lieut. J. R. Travers Aldous, M.C., R.E.; Miss Charlotte Yellowley Loftus Brock; Richard Coke, M.C.; Sir Iain Colquhoun, Bart.,

D.S.O.; Miss Alice Garnett, B.A.; Major F. L. Gore, C.I.E., O.B.E.; Leo St. Clare Grondona; Allen Collier James, A.R.I.B.A.; Harry Lewis; Miss Florence Macdonald, M.B.E.; John Moorhead, B.A.; William Reginald Morse, A.B., M.D., C.M., A.C.S.; Frank Vivian Owen; Captain Ernest Henry Reynolds-Major, T.D., R.A.; Mrs. Ethel Mary Rosenthal; Sir Edward Davis Stern, Bart., D.L.; Geoffrey S. Williams.

PAPER: The Alps of Qungur. C. P. Skrine.

Thirteenth Evening Meeting, 11 May 1925.—The President in the Chair.

ELECTIONS.—The Rev. F. C. Cuthbert-Atkin; Mrs. L. G. Angas; Hiram P. Bailey, C.B.E.; Robert Ashley Baldry, B.A., F.G.S.; Captain Joseph E. Bernier; James John Bolt, A.I.C.S.; Douglas Oliver Brumage; Rupert Allen Carr; Brig.-Gen. H. A. Chandos-Pole-Gell, J.P.; Milton Victor Douglas; Stewart Fraser; The Rev. Oswald Henderson; The Rev. James Arthur Jones; Alderman Arthur Thomas Keirle, J.P., F.R.C.I.; The Ven. Archdeacon Edwin H. Knowles, LL.B.; George Long; George Augustus Nicholas; John Isdale Miller; Maurice Oppenheimer; Arthur Pereira, F.R.P.S.; Captain John Stanley Pring; Frederic Bannerman Rees; John Arthur Reid; Maurice Allan Robinson; Douglas David Seligman; William H. Smith; Major Alfred Jesse Suenson-Taylor, O.B.E., M.A.; Harold Willoughby Thomson; Horace George Waldram, B.A.; Jonathan Railton Walker; John Barthrop Welman; Mrs. Helen S. Wright; Captain Michael James Whelton, M.C., R.A.M.C.; Albert Victor Wiskar.

PAPER:—The Dead Sea to Aqaba. H. St. J. B. Philby.

Seventh Afternoon Meeting, 18 May 1925.—The President in the Chair.

PAPER: The Physiography of Mount Everest. N. E. Odell.

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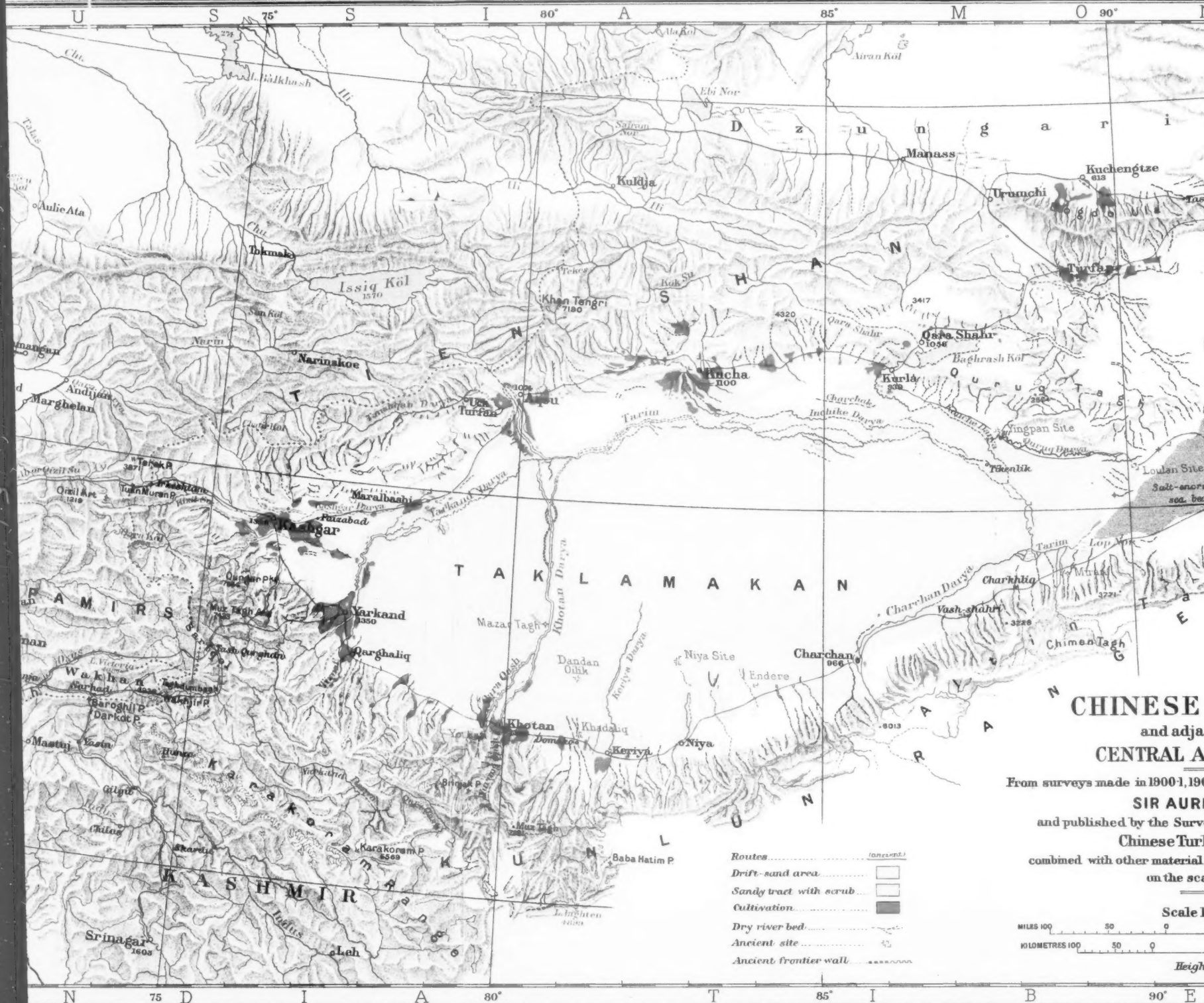

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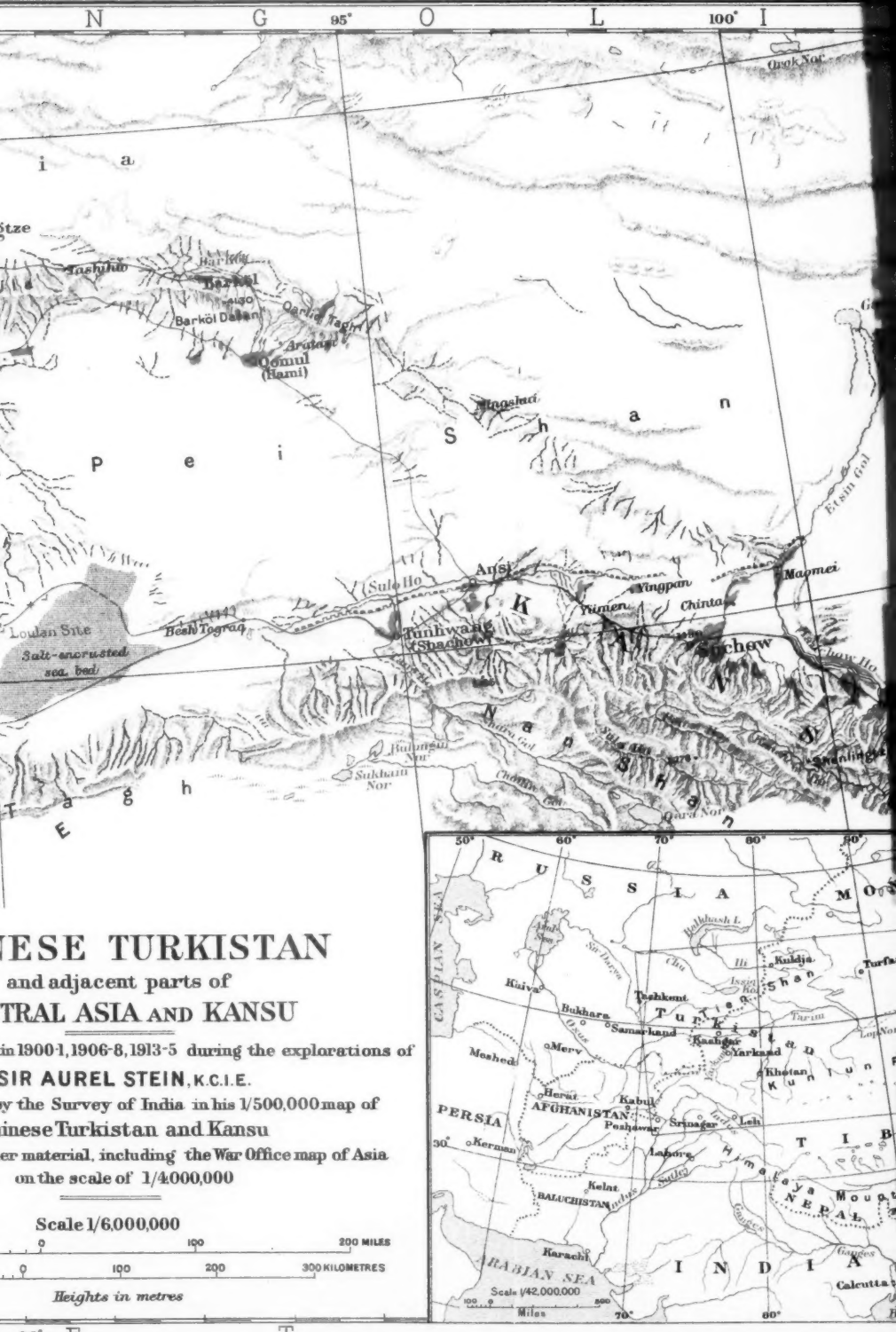

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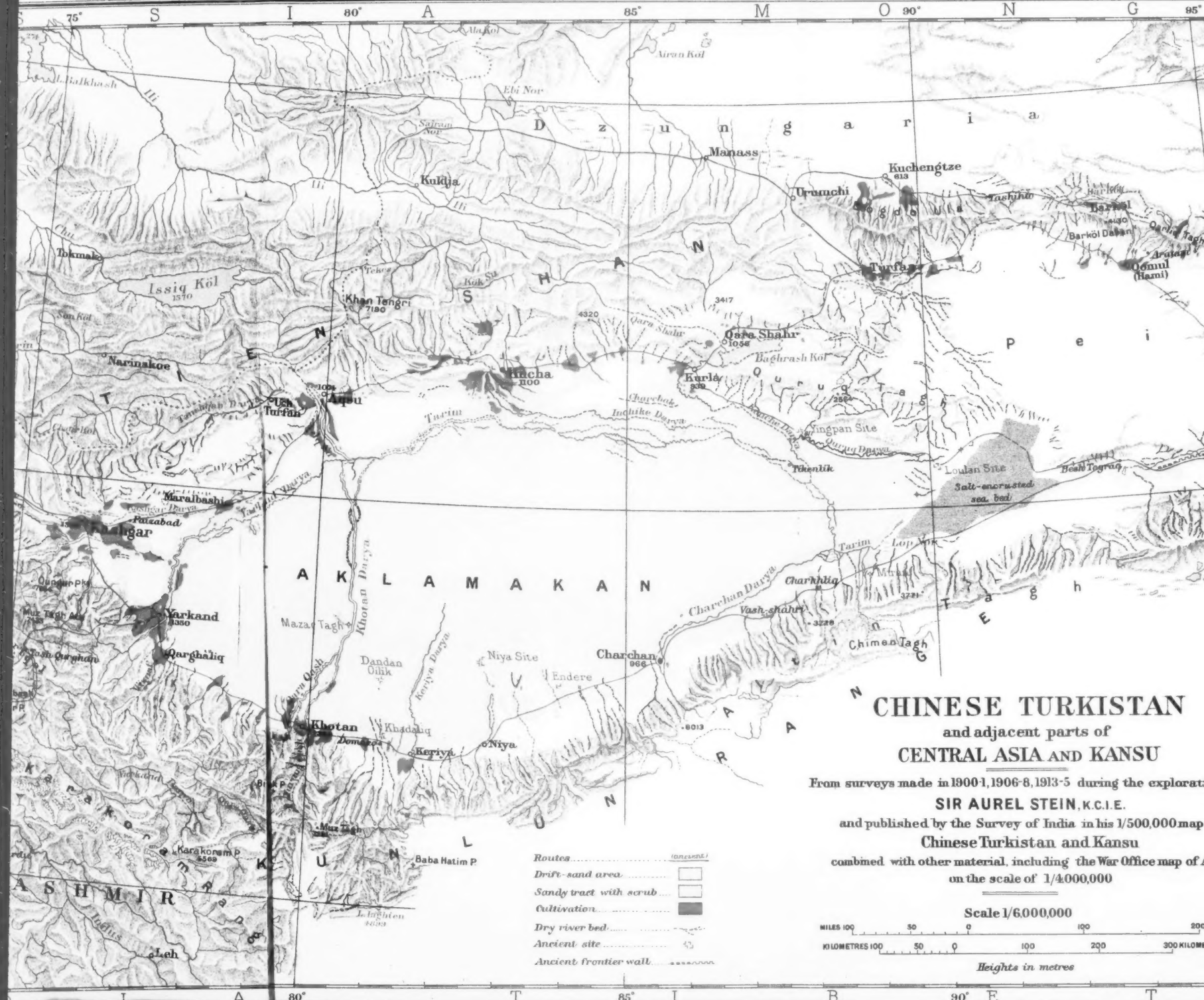

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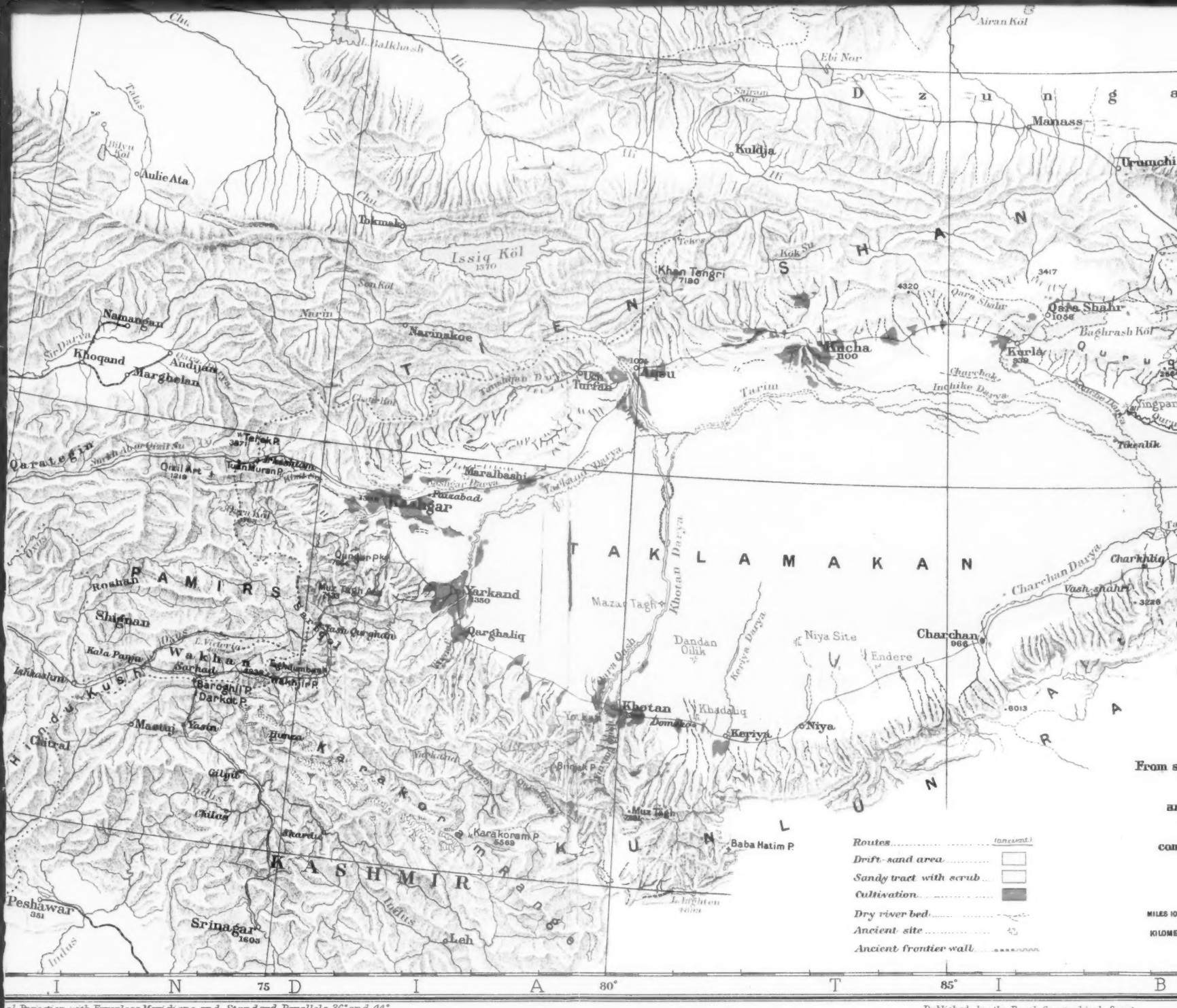

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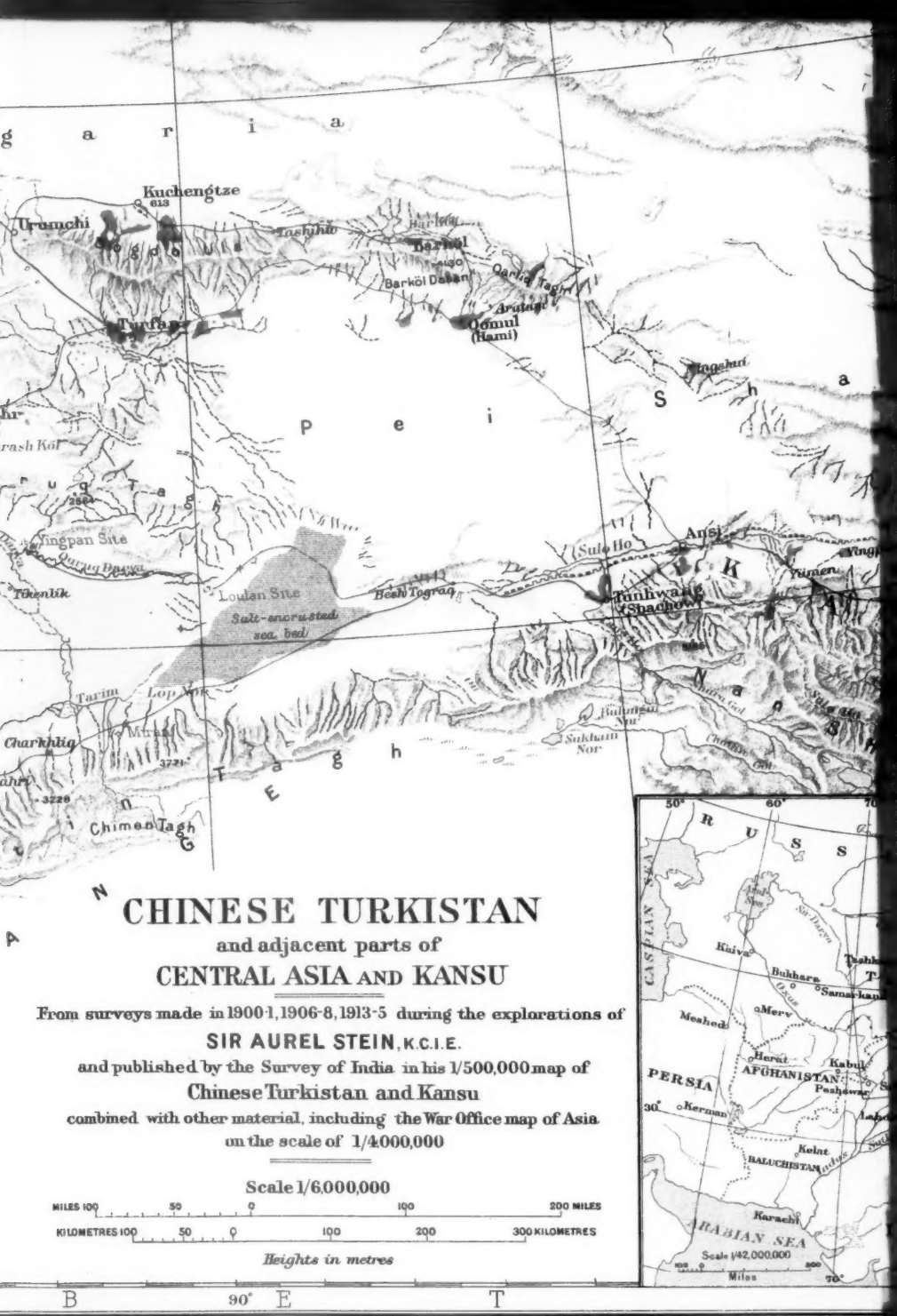

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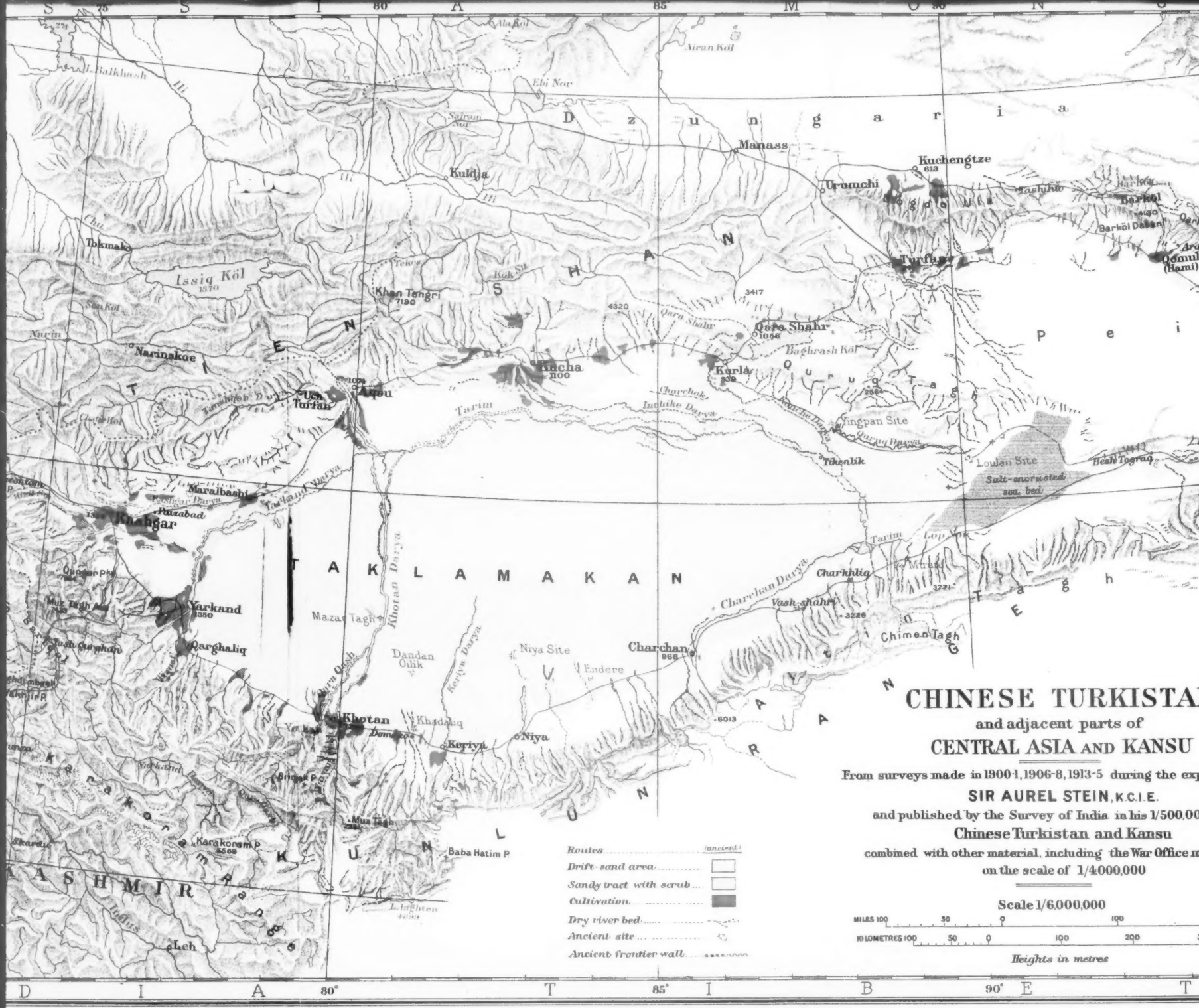

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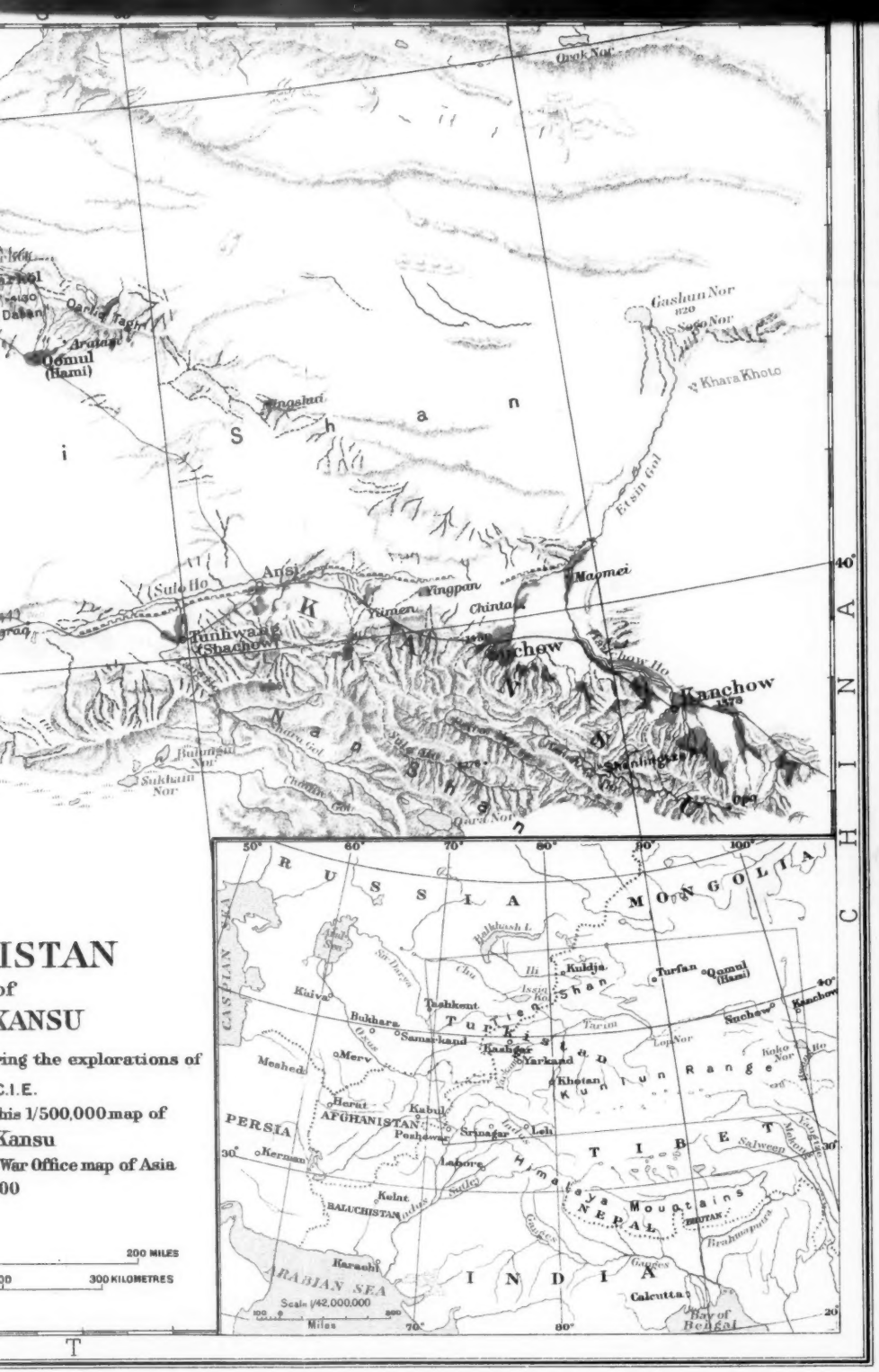

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THE CHAMBERS OF COMMERCE ATLAS

PREFACE

NO more marked changes in any sphere of human activity have been brought about by the Great War than in that of international commerce and economics. There are many contributory causes to explain the changes that have taken place in international commerce since the War, but it will be sufficient for our purpose to mention some of them. Many of the nations that were engaged in the War are bearing crushing loads of debt. Over a wide area in Central Europe and Russia there has been a state of economic and political chaos. The exchange rates in many countries have been subject to violent fluctuations, and generally throughout the world there has been evidence of widespread social and industrial unrest. The reduced purchasing power of exhausted nations is reflected in the restriction of commerce, and distracted Governments have endeavoured by the imposition of prohibitive tariffs to encourage local industry.

The introduction of these new factors in the world of commerce has made it essential for business men to obtain fresh information concerning the conditions affecting industry in all countries, and a thorough knowledge of the present distribution of commodities available for commerce. In no country is this more important than in the United Kingdom, where the population depends for its existence upon the maintenance of its Imperial and foreign trade, by which alone it can command sufficient supplies of food and raw materials that are not produced in these islands. A wide knowledge of economic geography is by no means easy to acquire; the ramifications of modern industrial enterprise are endless, and hitherto there has existed no systematic survey embodying in a convenient form the essential facts concerning the distribution and value of the world's commodities, international economic relationships, existing industrial enterprises, and the means of communication which link the peoples of the world together. To provide within the covers of a single volume a general survey of the economic activities of mankind has been the object of the publishers in preparing, in conjunction with The Times TRADE AND ENGINEERING SUPPLEMENT, the new Chambers of Commerce Atlas. The authoritative nature of this publication is manifest from the fact that it has been compiled with the cognizance and assistance of the ASSOCIATION OF THE BRITISH CHAMBERS OF COMMERCE. The editors had the advantage of consulting the President and Secretary of the Association as to how their work could be made of the greatest practical value to business men, and desire to acknowledge the help that they rendered in making numerous practical suggestions, all of which have been embodied in the contents of the Atlas. The editors are further indebted to a number of affiliated Chambers of Commerce for much valuable information, and to Admiral Henry H. Campbell, C.B., C.V.O., for permission to use his "K" Classification of Commodities, which has been adopted by the Association, and has been followed as far as practicable throughout the Atlas. The editors also gratefully acknowledge the assistance afforded them by many Government and other official departments, and by the heads of many leading commercial houses in supplying and checking figures relating to separate commodities and industries. A list of those who have helped to provide authoritative information from the most recent materials available is printed elsewhere in the Atlas.

That the CHAMBERS OF COMMERCE ATLAS adequately covers the many spheres of economic geography in which business men are individually interested may be gathered from a brief summary of its principal contents.

The CHAMBERS OF COMMERCE ATLAS presents in a series of coloured maps, diagrams and the necessary letterpress the main features of economic geography, with particular reference to the British Empire. It contains 112 pages of coloured maps and diagrams, designed to present statistical economic information in a form—hitherto never attempted in a commercial atlas—to make direct appeal to the mind through the eye. A series of maps deals with the DISTRIBUTION OF THE COMMODITIES OF COMMERCE. In these, appropriate units of weight, number or value, have been selected for each commodity, each unit being represented on the maps by a coloured dot; and since on all the distribution maps an equal area projection for the land masses has been adopted—a modification of Goode's "Homolographic" Projection—the representation of the comparative importance in the yield of each commodity in different regions of production is shown

THE CHAMBERS OF COMMERCE ATLAS

PREFACE—*continued*

by the relative closeness of the dots to each other, and is at once diagrammatic and scientifically accurate. Over one hundred commodities are treated in this way, and the information on the maps for each commodity is supplemented by a series of diagrams and articles giving exhaustive statistical and technical details of interest to the business man.

Means of communication and transport have been exhaustively treated. In a series of maps, showing rail, steamer and aeroplane connexions, wireless stations and cable and telegraphic routes are shown; British, United States and other foreign steamship lines are marked in distinctive colours; coaling and oiling stations, docks and other features of marine interest are indicated.

A large section of the Atlas is devoted to economic maps, illustrating the COMMERCIAL DEVELOPMENT of the principal countries. In this section special prominence is accorded the Home Country and Overseas Dominions. On these regional maps the main agricultural, industrial and other occupations pursued are indicated in colour. The animal, mineral and vegetable resources, the extent of the foreign trade with other countries, and the principal hydro-electric stations in use for industrial purposes also are depicted. They, therefore, serve to supplement the series of maps dealing with the distribution of individual commodities, since they bring together for each region all the products the exploitation of which absorbs the industrial activities of its people.

Among the remaining features of interest contained in the map section of the Atlas may be mentioned maps showing:—

THE BRITISH EMPIRE and other Political Groupings in 1924 and 1914; BRITISH (and United States) DIPLOMATIC AND CONSULAR REPRESENTATION ABROAD, British Chambers of Commerce in Foreign Countries, British Trade Commissioners' Areas, and Lloyd's Agencies; PRINCIPAL FAIRS AND DISTRIBUTING MARTS, and maps showing the DISTRIBUTION OF MANKIND ACCORDING TO RACE AND THE AVAILABLE SOURCES OF WATER POWER utilized for manufacturing purposes; while among the extensive series of comparative diagrams may be named diagrams of the area and population of the chief countries of the world, the area, population and racial constituents of the British Empire; occupations, mercantile marines, postal, telegraph, telephone, cable and wireless statistics of the chief commercial countries; mileages by rail and navigable waterway, and lists of railway and steamship distances and of British and United States Consular Representatives.

Lastly, the information contained in the map section of the Atlas is supplemented by a COMPENDIUM, dealing comprehensively with all the commodities of commerce, including those of minor importance for which room could not be found among the coloured maps; and supplying all the information likely to be of practical value to the business man. The contents of this compendium are arranged in alphabetical order, and its value to merchants and shippers is greatly enhanced by the fact that with the kind permission of Admiral Henry H. Campbell, C.B., C.V.O., all commodities have been classified under the reference numbers used in the "K" Dual Classification of Commodities prepared by him and adopted by the Association of British Chambers of Commerce. For the convenience of business men this "K" Form has been included in the Atlas, together with an alphabetical list of its contents.

The publication of a reference work of the magnitude explained above, devoted so largely to a survey of our widely scattered Empire, comes at an opportune time, when the eyes of the whole world have been—and will continue to be—fixed on the display of our vast Imperial resources—actual and potential—at the British Empire Exhibitions of 1924 and 1925. The editors are fully conscious that in a work covering so wide a field, and based on so many sources of information, some of which owing to the economic and political disturbances of the time and the fluctuations of the Continental exchanges must be regarded as of doubtful reliability, some errors and omissions are bound to have occurred; but they trust, with the exceptional advantages they have enjoyed through the co-operation of so large a number of Government and other official bodies and of trade experts in every branch of industry, that the CHAMBERS OF COMMERCE ATLAS may come to be regarded as an indispensable work of reference, alike of practical value to the commercial community, and of educative importance in the training of students in schools and colleges—in short, a not unworthy contribution to the commercial literature of the Empire.

GEORGE PHILIP.
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May, 1925

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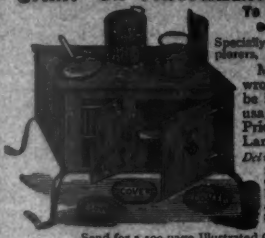

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